OIL, GAS AND PETROCHEMICAL PROCESSING

Petroleum Refiner

JANUARY
1960

MAINTENANCE SUPERVISOR'S HANDBOOK

Organization
Inspection
Instrumentation
Cost Records
Painting
Turnarounds
Planning and Scheduling
Preventive Maintenance

Starts on Page 115

PLAN NOW

What's Ahead for Petrochemicals 167

MANAGEMENT VIEWS

Growing Problem of Labor Monopoly 241

For a "Quick Look" at this issue, turn the page . . .

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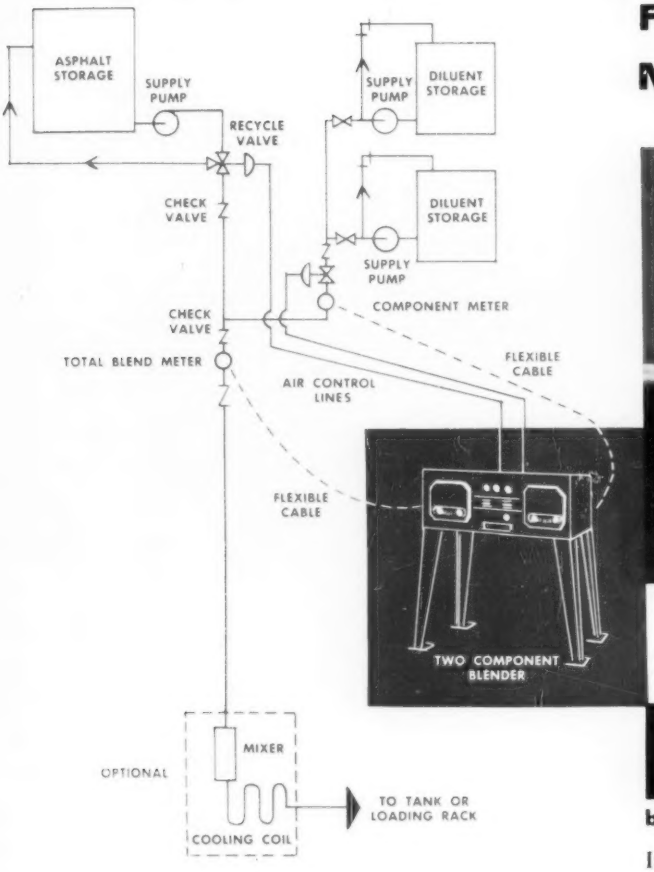

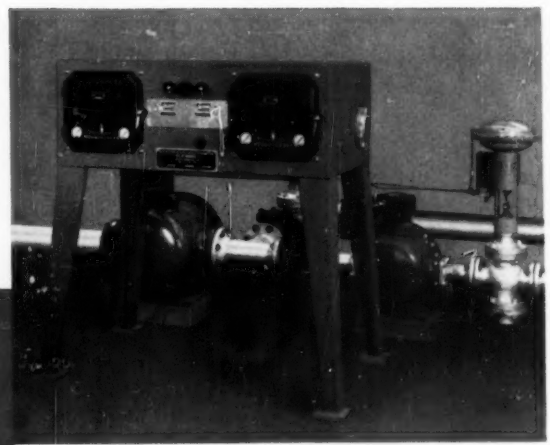

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Volume 39, No. 1 January 1960

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Petroleum Refiner
OIL, GAS AND PETROCHEMICAL PROCESSING
A Gulf Publishing Company Publication

A Quick Look at This Issue

These handy digests permit checking the articles you want to read first. ☑

☐ **Maintenance Supervisor's Handbook.** Labor costs are the largest factor in maintenance expense. One study said that direct labor costs runs between 40 and 50 percent of total maintenance costs. Therefore, close control of labor costs means control of total maintenance costs.

This handbook (**Page 115**) covers the supervisor's control of labor costs. It points out the different viewpoints in the petroleum processing industry for managing maintenance departments. Here are the chapters you'll read:

Part 1: The Maintenance Organization. Here's a discussion of typical maintenance organizations with reasons for operating under the different plans. It starts on **Page 116.**

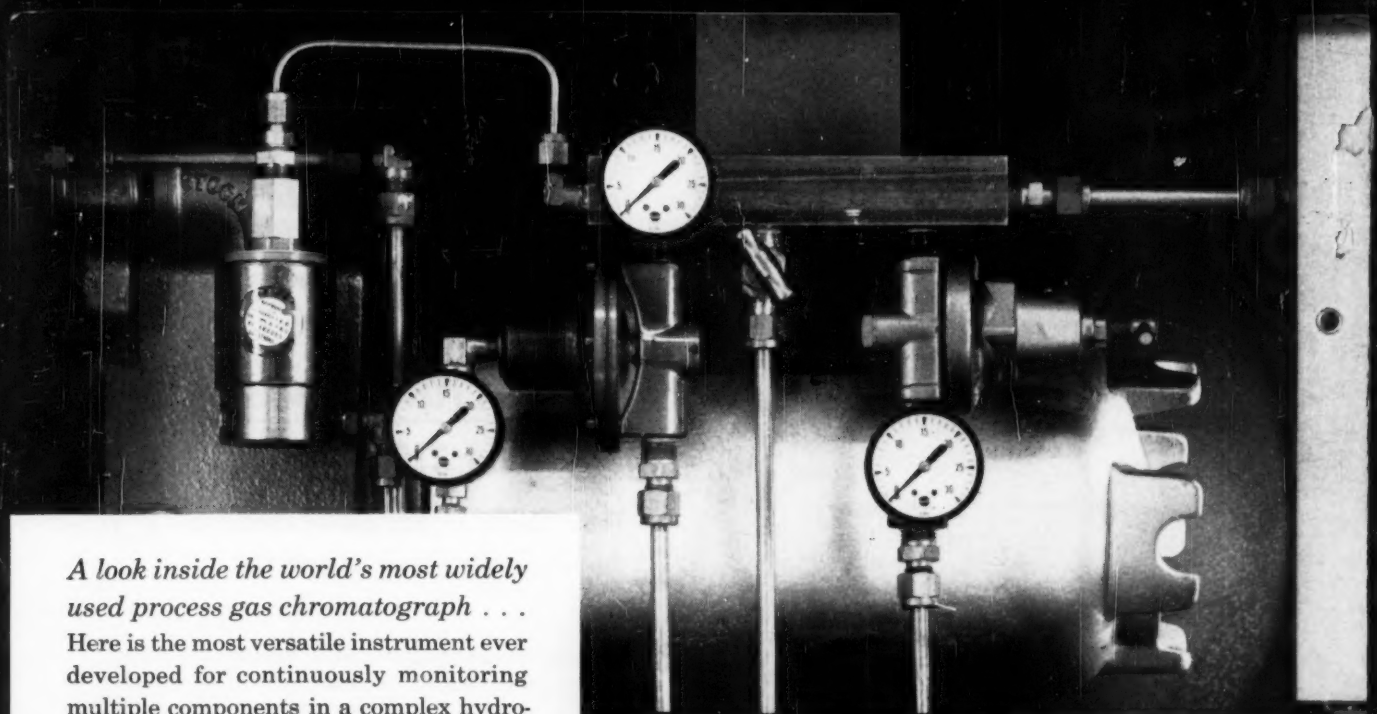
Part 2: Planning and Scheduling. You'll find each phase of planning and scheduling covered along with viewpoints from major operators on the success of the various plans. For this part, turn to **Page 122.**

Part 3: Preventive Maintenance. This part discusses the different PM programs being carried on today, how they are operated, and the records which need to be kept. It also gives PM details on major types of equipment. **Page 129.**

Part 4: Inspection. Here's a good run-down on how far you can go with inspection to reduce maintenance costs without adding to them. To check on your inspection, turn to **Page 135.**

Part 5: Keeping Cost Records. Cost records are essential to the maintenance supervisor in a modern process plant. This chapter points to which records you need to keep and what they tell the supervisor. Details start on **Page 141.**

Please Turn Page ➡



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It's a Fact: While a cat cracker produced enough gasoline to power every automobile in the U.S. for 200 miles, a Beckman Oxygen Analyzer continuously monitored the catalyst regeneration with only routine cleaning and adjustment required.

A Quick Look at This Issue . . .

Part 6: Turnarounds. Organizing and planning this special operation is the important job of the maintenance supervisor. This chapter tells you how several major companies view this vital maintenance function. Turn now to **Page 147.**

Part 7: The Instrument Department. With automation playing such an essential role in modern process plants, managing an efficient instrument department takes on a new meaning. For details on how several plants have taken a new look at their instrument departments, turn to **Page 152.**

Part 8: Maintenance Painting: A routine operation, yes, but one that eats heavily into the maintenance budget. Pick up these ideas on cutting painting costs by turning to **Page 156.**

☐ **New Potassium Carbonate Process . . .** With these operating conditions, its possible to remove CO_2 and H_2S from natural gas to pipeline specifications with an all carbonate process. Check this article for pilot plant data on this removal. Turn to **Page 159.**

☐ **Applied Hydrocarbon Thermodynamics . . . Part 15b: Flash Vaporization Conditions and TBP Curves of Equilibrium Vapor and Liquid from Terminal Volatilities** . . . You'll find sample calculations for estimating TBP curves for three flash vaporizations for each of two stocks. Since complete experimental data are almost nonexistent you have to become familiar with these empirical methods. See **Page 161.**

☐ **Petrochemicals Set Stable Pace in '60 . . .** Careful study of the past two years indicate price and production stability in 1960. However, you'll need to start planning now for expansion in the early sixties. For the petrochemicals to watch, turn to **Page 167.**

☐ **Physical Properties of Liquid Xylenes . . .** is another useful nomogram for quickly picking off properties of all three isomers. Turn to **Page 170.**

☐ **Automation Today, Part 17 . . .** The Nyquist diagram is used to represent a familiar control problem. Now you can see how this type of representation helps study the response of a process and its control system. The influences of proportional, derivative, and integral controls are included in the discussion, and their effects are shown on Nyquist diagrams. Examine the usefulness of this technique by turning to **Page 171.**

☐ **A Yardstick for NPSH Requirements . . .** It has been generally assumed in the oil industry that oils require less pressure at the suction than water. However, two common methods of taking credit for this supposed property are now open to question and a new method is proposed. To see how this method will fit into your pump design calculations, turn to **Page 175.**

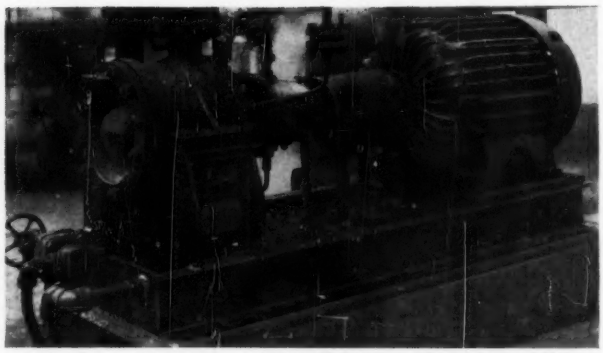
☐ **Figure Octanes of Blends This Way . . .** This new method permits the prediction of octanes even when one or more of the components is rich in aromatics. All you need to know are the paraffin plus naphthene concentration and the octane rating of each component. A nomograph is used to make the calculation easier, **Page 181.**

☐ **Operator's Handbook for Gasoline Plants . . .** The sixth part to this series discusses rotary pumps. It's designed to simplify the equipment and operations of a natural gasoline plant for the new and experienced operator. You'll want to be sure to read this part which starts on **Page 185.**

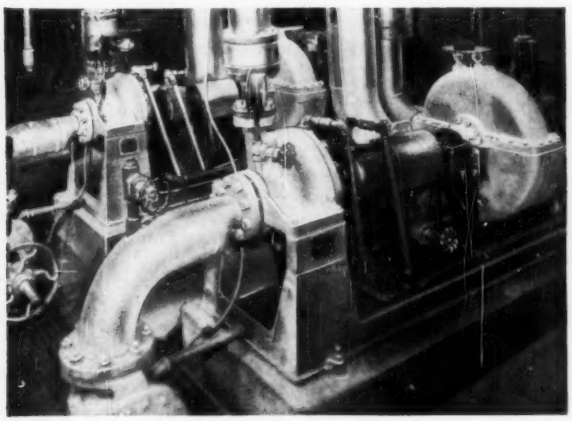
☐ **The Growing Problem of Labor Monopoly . . .** In 1914, the Clayton Act exempted labor unions from anti-trust action. Since that time they have been permitted to grow and combine until today they constitute the most flagrant example of monopoly control this nation has ever witnessed. Here's an article which not only recognizes this problem, but proposes a solution as well. You'll be well informed on why we need new legislation after you start reading on **Page 241.**

☐ **Test Yourself on Labor Relations . . .** Here are three actual labor relations cases which resulted from plant grievances. You'll not only gain the knowledge that these three cases offer, but before reading the answers, you'll get the opportunity to test yourself on how the arbitrator ruled. You'll enjoy and benefit greatly from this new and interesting PETROLEUM REFINER feature, so turn now to **Page 246.**

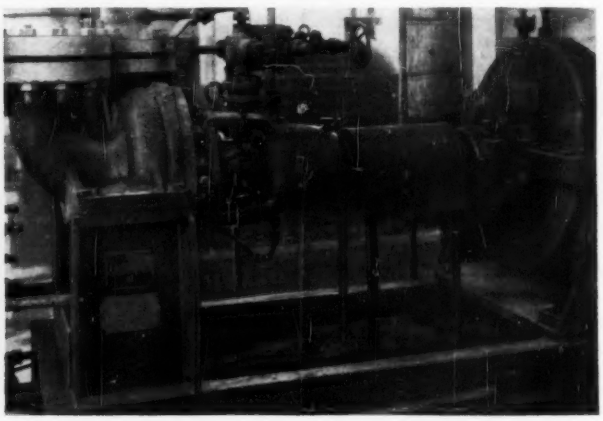
☐ **Old Units Do Explode! . . .** Here's the full story of the explosion that rocked the Ponca City refinery of Cities Service last January. Of course, Indiana-Standard's violent hydroformer detonation in 1955 emphatically revealed the potential hazard of modern catalytic regenerative processes but who would have looked for the same potential hazard in a coking process operating for more than 30 years? Be sure to read this latest report of a major explosion. Turn to **Page 248.**



Size 1½" x 2" 2-stage pump handles light hydrocarbon mixture at 900 feet differential head operating at 3,500 rpm.



Size 2" x 3" x 13" pump handles 365 gpm of boiler feed water at 300 psi discharge pressure operating at 4,400 rpm.



Size 4" x 6" x 13" pump handles 780 gpm of hydrocarbonbutane mixture at 470 feet differential head operating at 3,500 rpm.

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PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.

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How Is Your Labor IQ?

A BRAND NEW "As Management Sees It . . ." feature called "Test Yourself on Labor Relations" appears this month, Page 246. Actual case histories of labor grievances are presented and the reader is asked to deduce how the arbitrator ruled—and why. The answers and opinions of the arbitrators are presented on a different page. "Test Yourself on Labor Relations" will be listed each month right along with the rest of the popular "As Management Sees It . . ." which section has become a regular part of the reading habits of a mass of PR readers. The Labor Relations test would be a good starter if you are not already included in this group.

Basic and Complete

"SPECIAL REPORT" treatment of topics related to the processing industry have characterized PETROLEUM REFINER over the past several years. Scarcely a month has passed, except where there are Special Issues, when one of these special reports was not presented in PETROLEUM REFINER. Regular readers of this page will recall having read several references to one Special Report or another as they have appeared. Now comes a Kansas subscriber and with a neat phrase or two tabs these reports so effectively that we'll just borrow his composition and let it apply to all:

"Of particular interest to me are the Special Reports on particular subjects because they give basic data not usually found in technical articles, and they also cover that particular field completely giving all the alternatives and different kinds of materials and equipment for that use."

Leading Text

WE'VE SEEN IT in at least one other technical magazine since this thought, expressed by Peter J. B. Stevens, originally was published in the May 1959 issue of "Industrial Marketing":

"Today's engineer must literally educate himself on a day-to-day basis to keep abreast of the work in his field. And in this continual self-education, *technical publications are his textbooks.* They are the medium by which engineers exchange current information of common interest."

PR, we are proud to say, is the leading text in the oil, gas and petrochemical field. We are even prouder that the technical men in these industries concur by their support in the form of subscriptions.

We're pretty proud, here on PETROLEUM REFINER, of an upcoming presentation on the design of the thermosiphon type of reboiler. The author is Dr. James Fair of Monsanto Chemical's R&E Division whose big contribution is to incorporate some tricky two-phase flow concepts into easy-to-use design charts. These plus other data have caused one of our industrial reviewers to tag it as being very comprehensive. We add the obvious: High working and reference value here! It will be in our February issue.

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Quick Look at Industry...

Panning the Washington Scene for '60 . . .

Look for some legislation to affect oil in 1960. But being election year, lawmakers will probably shy away from anything too controversial or with narrow appeal—also, national conventions by both parties in July will cut short legislative sessions. Here, though, are three big ones to watch:

- Another boost in federal gasoline taxes—President Eisenhower will push for this in spite of the tough sledding he had with the one-cent temporary increase Congress passed in '59. Last year, though, Ike put on the pressure by saying road building would grind to a halt without the hike—but now he has no such lever. On top of that, Congress will be reluctant to raise any taxes so shortly before election. Considering all, chances look dim for this one.
- Push for Foreign Investment Bill—Tentatively approved by House Ways and Means Committee, measure would grant more tax credits on foreign earnings as incentive for U.S. corporations to invest overseas. Those rallying around this bill say it's plain good business for Uncle Sam—with private dollars in countries, not as much has to be given in foreign aid. Give this a 60-40 chance to pass.
- Reduction or elimination of percentage depletion—very little possibility of any legislation along these lines. It will be discussed, though, and more than likely will be target of hot Congressional debate. But those who want it most still don't have the support they need—then too, House Ways and Means Committee Chairman Mills (D-Ark.) feels provision is needed as recovery against capital loss.

Hydrogen Cracking Promises Help . . .

Last month it was Isocracking—a product of CRC. This month it's Unicracking, recently developed by Union Oil of California. Both promise to upgrade middle distillates to high-quality gasoline. Possible results: 1) an out for lagging distillate market; 2) a boost to gasoline production.

States Diverting Highway Taxes . . .

API contends states diverted whopping $303 million-plus in 1958 highway-user taxes that should have been used for roads—represents 6.5% of the $4.7 billion collected. California, Florida, New Jersey, Washington, Oklahoma, Rhode Island, Texas and D.C. accounted for 86% of total diverted. On the other hand, 20 states did not siphon off a single penny.

Trend to Many Gasoline Grades . . .

More impetus to multigrade gasolines. Signal Oil and Gas tested system in Nevada—now adding multigrade pumps in California. Sun Oil has been using this marketing technique several years.

Quick Look Around the Country . . .

Rep. Hechler (D-W. Va.) charges FPC with not doing its job—will seek sweeping Congressional investigation unless Commission acts to halt "skyrocketing" natural gas prices . . . Sen. Morse (D-Ore.) seeking evidence that State Dept. oil policies driving some Latin American countries into accepting Communist credits for equipment purchases . . .

New president of Esso Standard is O. V. Tracy. Succeeds William Naden, new VP and director of Humble (Del.) . . . BuMines pegs domestic demand for all oils in '60 at 9,864,000 bpd—up to 3.9 percent over '59 . . . FPC approves merger of Pacific Northwest Pipeline into El Paso Natural Gas . . . Dehydrogenation unit sets off double explosion and small fire at Texas Butadiene & Chemical plant—cause unknown.

Rubber Outlook Looks Bright . . .

Looks as if U.S. rubber consumption in '59 will exceed 1.6 million long tons for 17% increase over '58. Looking ahead to '60, demand should climb to 1.65 million long tons—a new record. Important point is that more than two-thirds will be synthetic.

Tire manufacturers will be busy producing more than 500,000 tires daily to meet expected record demand of 127 million tires in '60. All told, autos consume about 12% of rubber output—therefore high record auto production will certainly hike rubber consumption.

Japanese Firm Continues Red Oil Import . . .

One of Japan's largest oil importers, Idemitsu Kosan K.K. will continue sizable purchases of Russian crude if quality and price hold. Company recently concluded contract for 33,000 tons. Japanese Ministry of International Trade and Industry is anxious for Japanese refiners to import as much oil as possible from Soviet Union—but many major firms reluctant to buy because of high price and instability and uncertainty of supply.

Refining Profits Up . . .

Refiners, including integrated companies, reported $656 million in net profits for third quarter '59. Represents $8 million gain over year earlier—$35 million over second quarter.

Panning the Building Scene . . .

Shell International sends team to Malay Peninsula to find sites for two refineries—one will cost about $12.9 million and is slated for Singapore—the other will run slightly more than $20 million and is due to be spotted in Malay . . . Sun Olin plans $15 million ethylene plant at North Claymont, Del.—will take dry gas from Sun Oil's Marcus Hook Refinery . . . California Standard starts construction of 20 million lb.-a-year maleic anhydride plant at Richmond refinery. On stream date: mid-1960 . . . Shell Chemical Australia to build ethylene plant at Shell's Clyde refinery near Sydney—completion set for '62. Plant will eliminate imports of material from China, East Germany and other points.

Polyethylene Finds Many Markets . . .

Market for polyethylene keeps increasing as more uses appear. Latest on the scene is polyethylene film spread over construction sites and supported with air from low-pressure fan. Result: giant balloon which keeps workman warm and dry, yet provides plenty of light to work by. Another new use could save close to billion dollars yearly in crop damage. Here polyethylene helps fumigate soil and kill insects as strips are tacked to the ground and fumigating chemicals are placed beneath them.

Uncle Sam as Strike Breaker? . . .

Oil Chemical and Atomic Workers Union charges military's receiving jet fuel from Indiana Standard's struck Sugar Creek plant puts government "in position of strike breaking." Plant management contends "It's legal, and beyond that we see no further need for comment." OCAW boss, O. A. Knight says Defense Dept. will investigate fully.

B&W has taken the step...

a NEW PLANT at Beaver Falls for the manufacture of a

COMPLETE LINE OF WELDING FITTINGS AND FLANGES

Beaver Falls, Pennsylvania is the site for B&W's new Welding Fittings plant. When in operation it will be one of the most efficient sources of supply in the industry... one that has been designed with product quality as well as customer service in mind. Not only will it have facilities for the manufacture of a complete line of carbon, alloy and stainless steel fittings and flanges, but its location makes possible integration with B&W's other manufacturing operations... their steel mills and their tube mills.

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(c) you can more effectively control both buying and delivery from one manufacturer... The Babcock & Wilcox Company

An announcement of the transfer of welding fittings operations from Milwaukee to Beaver Falls will be made in the near future.

For further details ask for bulletin FDM-2016 or call on any of the local B&W District Sales Offices. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

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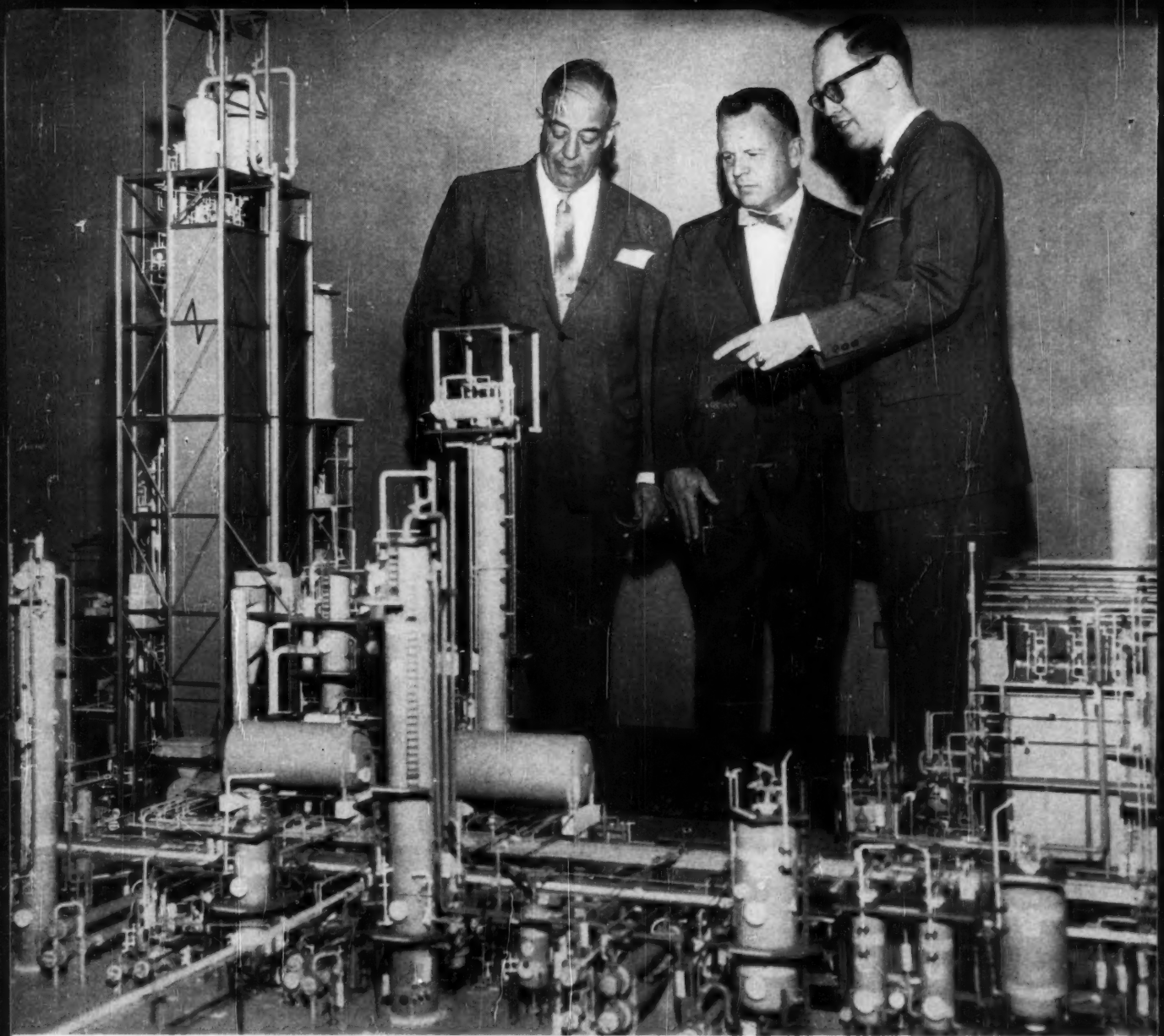

SEEING IS SAVING...

One important advantage of plant models is that managements can fully exercise their judgment and experience in approving design and layout *before* construction starts.

Here, SunOlin Chemical Company vice-president S. S. Johnson and president James I. Harper are shown reviewing, with Kellogg project manager Robert Jacks, details of their new 200 ton/day urea plant—now being built by Kellogg, using the Fauser-Montecatini Process.

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A Game with Familiar Rules

This editorial on the "Something for Nothing" theme first appeared in our November, 1959 issue, and is being printed again by request, this time in a fashion that can be easily removed for circulation or display. Free reprints for distribution to employes, et al. may be had by addressing the Editorial Director.

A BUNCH OF THE BOYS were just sitting around playing a little poker the other night when one of the players looked up and said, "What we need to do is invent a poker game where everybody wins."

Of course we all laughed at first. Then someone ventured that this really would be a good idea and the more we talked about it the better it sounded. So, we began to give it some serious thought—could we actually come up with a poker game where everybody would win?

"This would really be terrific," said Clem who owns a little farm just outside of town. "If I could just win enough so that I wouldn't have to plant a crop this year I could do a lot of things I have been putting off for years."

"That sounds O.K.," I told him. "Here's what we'll do, Clem. We'll let you win enough to pay you for not planting a crop this year. Besides, there's plenty of acreage around here and without your crop there will be enough of a shortage to keep the prices up for the rest of the farmers in the area."

"Swell," Clem agreed, "that will make everybody happy!"

"Tell you what I'd like," said one of the players named Pedro. Actually Pedro is not a regular member of our poker club—he's an official of a foreign government who's just visiting our town for a while.

Even a Repeat Basis. "What I'd like," Pedro repeated, "is to win enough money so our government could start a couple of industries back in my country."

"Sure, and you can come back at least once a year —and more often if you really get in a bind," we told him. "But since you will win this money in our poker game, you must promise that you will always like us."

"Agreed," said Pedro with a broad grin.

"Say, I have a terrific idea," piped up Jim.

"What is it?" asked a couple of the others in unison. Everyone seemed excited with the idea now.

"Let's take a small portion out of the kitty every now and then and put it in a special account down at the bank. Then after a few years we'll have a real nest egg to support all of us when we get too old or lazy to work."

"That's a great idea," I cried, "We'll just take out a small handful every so often, and in that way it won't be missed. Besides that, we could even give it a name. Let's see . . . how about Socialistic Security?"

"Oh, no," Jim responded quickly, "I don't want to have anything to do with socialistic schemes. Let's call it 'O. A. Security'—for 'Old Age Security'."

Everyone around the table nodded his agreement, then I spoke up as a thought came to mind. "You know, here's a good chance for us to fix up the old schoolhouse and to build a new bridge across Holler Creek. We could take a little out of the kitty for that."

"But I thought the state and local governments were supposed to handle that," Clem drawled.

"Usually they do," I countered, "but look at the money we would not have to pay in state and city taxes if we could take care of these projects from the game."

"Guess you're right," Clem admitted.

It's "Federal Ante." Since no one came up with anymore suggestions right away, we decided to start devising the game—this poker game in which everyone would be the winner. The first suggestion came from Bill.

"I'll tell you what," he said. "Since the word 'federal' means a union or joining, let's call our game the 'Federal Ante' and that will show that we all have a stake in it."

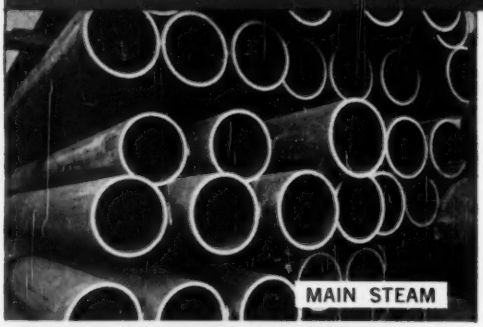
"Good, good," we all cheered.

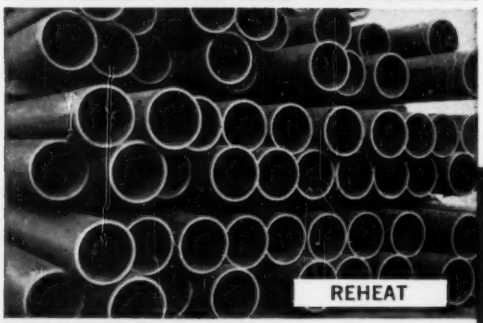
From then on, the ideas did not flow so freely, but finally after a while we settled on a set of rules where everyone would win. As we started to deal the first hand, we were all elated and rather proud for having come up with such an astounding idea. Personally I was at a loss as to why no one had thought about it before.

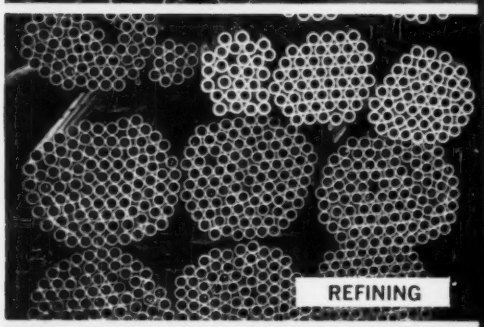
However, as we all threw in our usual ten-cent ante, those six dimes looked pitifully small for all we needed to win, so we upped the ante to a quarter. Still, this didn't look like enough, so we decided that since Jim had more chips in front of him than anyone else, he should ante more than the rest. At first Jim objected, but we told him that if he wanted to play, this is the way it would be, so he went along, although a bit reluctantly.

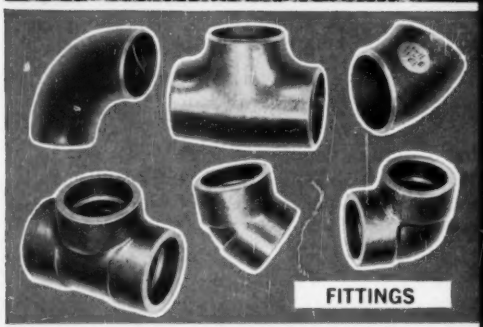
But even with some of the players anteing more than others, it was apparent that the pot was going to require a lot more. In our haste apparently we had forgotten to consider that the pot had nothing except our own contributions. In other words, it could only give back what we had put in in the first place.

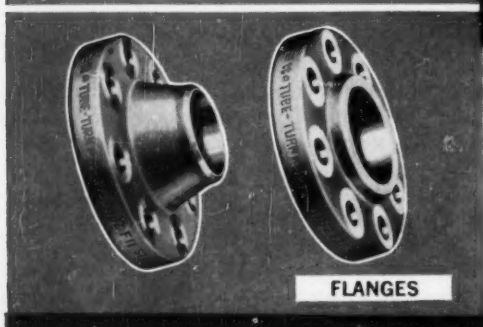
As we all sat there looking at the small stack in the middle of the table I could see the faces of the others reflecting the same thoughts which were running through my mind. And as I looked around I suddenly got the sensation that I had been through this whole situation before. I couldn't quite put my finger on it, but everything seemed so familiar . . .











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Danger Now—How About Then?

A RECENT ISSUE of the "OCAW Union News" discussed the possibilities of Congress legislating in such a way as to make government the boss from now on in labor-management disputes. Said the paper, "Government control of industry winds up being socialism if the people truly control the government, or it winds up being fascism if the corporation interests control the government. In view of the circumstances now prevailing and current attitudes held by the general public, either of these alternatives sounds rather dangerous."

We'll agree that it is remotely possible that a government controlled by corporations could lead to fascism—the same way a government controlled by labor could also lead to fascism. But, by the same token, a government controlled by fishermen, football players or even one man could lead to fascism too.

But here is the point we want to make: It is nice to know that the "OCAW Union News" considers socialism or fascism "rather dangerous" right now. What is confusing, however, is that just a couple of months ago, the "Union News" was advocating such socialistic schemes as:

1. Health insurance, sick leave and many other protections we seek against emergency to be handled through nationalized insurance, replacing company-sponsored plans.

2. Research and development of military equipment to be taken away from corporations and done by the government.

3. Expanding government guarantees of full employment so that people would not be entirely dependent on corporate policy for employment.

These are just three of the many, but it still leaves the question that if these schemes were so good just a couple of months ago, why is socialism "rather dangerous" right now? Perhaps this is just a case of bending with the breeze—but it might be interesting to find out where these breezes originate.

Once-a-Month Peek

ONCE A MONTH PETROLEUM REFINER devotes two pages to editorial comments of importance in the petroleum industry. You can find these editorials each month on pages 13 and 15 under the heading, "Look Box." This heading, adopted exactly 25 years ago, carries as a symbol the look box of by-gone days.

Back then, petroleum materials were separated almost exclusively with regard to color and gravity. However, the tasks once accomplished by peeking into the windowed "look box" have grown now to include inspection laboratories, complicated in-stream analyzers, quality control studies, and a host of other analyses geared to make more and better products.

So it is with PETROLEUM REFINER's Look Box pages. The subjects covered there will let you look into a whole gamut of petroleum processing and related activities. These discussions will give significance to past happenings plus more meaning to future ones. And so we believe this department will help you call your shots, just as the real look boxes helped the ol' timers.

Right Here In the Contract!

THE HIGH PRICE—to the oil industry and eventually to the consuming public—of craft unions exercising their contractual privileges was cited recently in a "Houston Chronicle" column, to wit:

They had the durndest set-to at one of the local refineries the other day, when a $10,000,000 catalytic cracker went off the production line because of a minor hole in a ½-inch steam pipe.

The operator sent in a hurry-up call for the pipefitters and the pipefitters hurried right over. The line was insulated, though, and the pipefitters wouldn't touch it until the insulation had been removed.

So a crew of insulators was sent for, and arrived. They reached up into the cat cracker's innards, located the faulty pipe, but decided it was too high to be worked on conveniently without a scaffold.

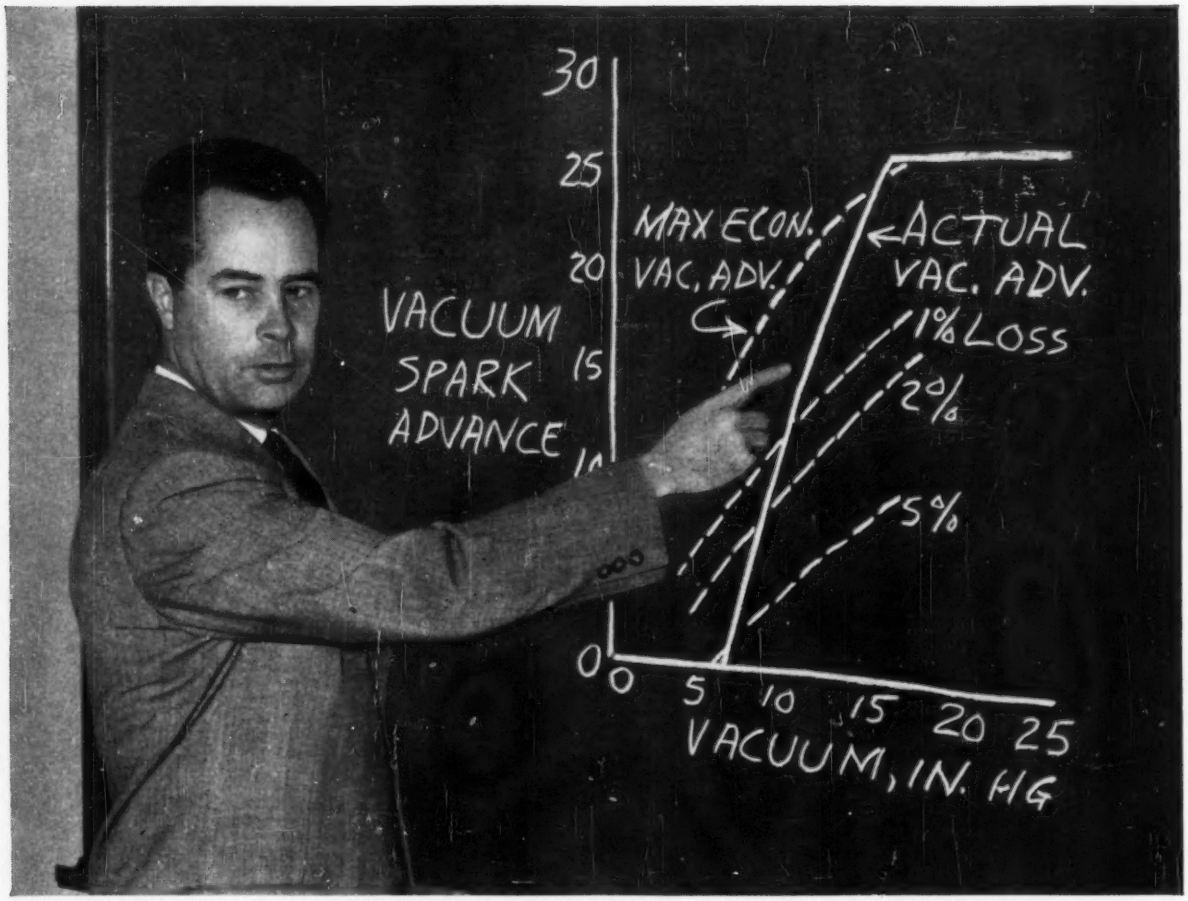
A crew of carpenters was sent for, and arrived. They took measurements and ordered the necessary lumber. Before a truck could bring the lumber it was coffee-break time and all hands knocked off. It's in the contract.

At length the coffee break was over and the carpenters went to work and built a foot stool for the insulators to stand on. The insulators stood on it and removed the insulation. Then the pipefitters stood on it and replaced the short length of ½-inch pipe. All fixed up in 20 minutes.

But the $10,000,000 cat cracker had been shut down for six hours while the various crafts exercised all their privileges.

Someone else recently said, and I share his anxiety, "If some day there is a burial place for the American economic system, it will be sad indeed if the epitaph should read, 'Here rests those who were so engrossed in the opportunities offered by the free enterprise system that they failed to defend it when it was being destroyed'."

J. H. DUNN, *President*
Shamrock Oil and Gas Corp.



Ethyl staff engineer Harry Toulmin explains how the engine designer develops a compromise vacuum spark advance curve.

Ethyl Research Studies Part-Throttle Knock

What causes it. How to control it.

DURING the past several years, knocking complaints have been recorded for certain premium-fuel-requirement passenger cars at part-throttle as well as full-throttle conditions.

Part-throttle knocking generally occurs at a point between full-throttle and road load, usually at low engine speed and from 8 to 14 inches manifold vacuum. Studies have shown that these conditions are frequently duplicated by the average motorist when operating his car in city traffic at low engine speeds.

Fuel Quality can control Part-Throttle Knock

When the problem of part-throttle knock becomes apparent in a particular car series through customer complaint, the difficulty can be relieved by increasing the Motor octane of the fuel or by adjusting the basic spark advance of the vehicle. A change in fuel quality would be more desirable since this retains top engine performance and maximum fuel economy.

What causes Part-Throttle Knock?

When the engine designer develops a new passenger car engine, a number of compromises are made to obtain optimum performance and durability for a given cost, weight and fuel requirement. One compromise is in the ignition advance curve. The full-throttle advance curve is usually retarded from maximum power by 1 or 2 percent in the mid-speed range.

This yields optimum engine power for a given octane requirement. By taking this small initial power loss, the octane requirement is reduced sharply—2.5 to 4 octane numbers. This establishes a full-throttle requirement for the engine.

To improve fuel economy at road load and between road load and full throttle, a vacuum advance unit is usually added to the distributor. This provides additional spark advance which adds to centrifugal advance at light engine loads. The spark advance curve cannot be set for optimum economy across the entire part-throttle

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range without increasing requirement excessively. So a compromise curve is used which gives the best economy without part-throttle knocking problems on typical motor fuels. If not enough compromise is made, the vehicle will be part-throttle knock limited.

Octane number requirement for such a vehicle is shown in the figure to the right. With sensitive reference fuel, octane requirement peaks at manifold vacuum of about 12″—and is a number higher than at full throttle. This is due to severe depreciation of sensitive fuels (those having large differences between Research and Motor octane) at light loads. Under these conditions, carburetor mixtures are leaner, mixture temperatures higher and exhaust gas dilution is greater—all of which contribute to the depreciation of the sensitive fuel.

Motor Octane is the Key

Since low sensitivity fuels are depreciated less than high sensitivity fuels, the part-throttle knocking problem is relieved by increasing the Motor octane number. This was substantiated recently in the Ethyl 1959 Premium Gasoline Antiknock Behavior study.

Road antiknock performance data were obtained on 30 premium fuels in five 1959 passenger cars. In addition, data were obtained in seven cars on two special sets of fuels, one with constant Research octane number and one with constant Motor octane number.

Both of these studies indicated that the most important fuel factor in controlling part-throttle knock is Motor octane number. In the low-speed range where most part-throttle knock occurs, Motor octane number has effectiveness of approximately unity, but Research octane has little or no effect on road octane number.

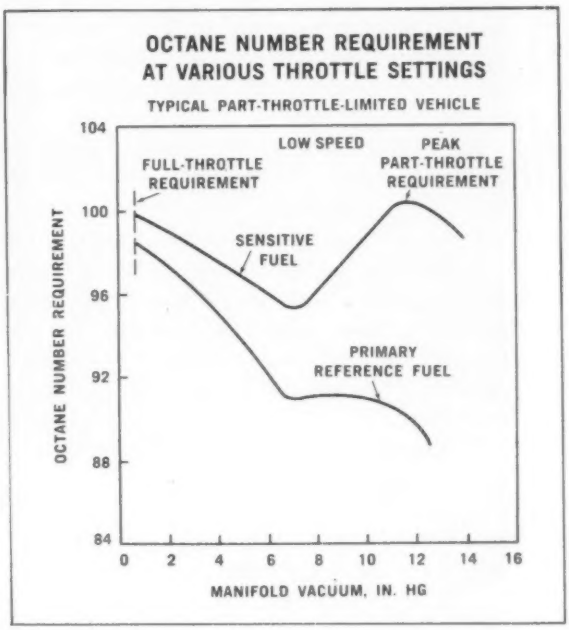
Fuel hydrocarbon composition has very little effect on road performance at low speed. In the high speed range (3000 rpm) an increase in Motor octane number of one unit will increase the road rating by two units, while an increase in Research octane number will actually decrease the road rating. At 3000 rpm an increase in aromatic content and a decrease in olefin content will increase the part-throttle road rating of a fuel.

Control by Engine Adjustment— A loss in economy

An obvious way to correct part-throttle knock is to reduce the spark advance at part throttle. This defeats the original purpose of the manufacturer since it reduces operating economy in this driving range.

A recent study showed that approximately 40 percent of the tank fuel is consumed in the 5″ to 15″ manifold vacuum range under some commuter driving conditions.

Further, a reduction of part-throttle spark advance can change the part-throttle response (acceleration) of a car, causing flat spots. This, in turn, can be corrected by enriching the mixture—a further loss of economy.



How Ethyl Research can help you

For a detailed discussion of part-throttle knock, ask your Ethyl Representative for copies of the Ethyl research paper, "Part-Throttle Knock," presented at the SAE National Fuels and Lubricants Meeting in Chicago, October 28-30, 1959.

Additional information on the subject of part-throttle knock can also be found in the Ethyl report entitled, "1959 Premium Gasoline Antiknock Behavior." Your Ethyl Representative will be glad to supply you with copies, or arrange for a presentation of this major project by an Ethyl Refinery Technologist.

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Fabrication of Phelps Dodge heat exchanger and condenser tubes starts with the casting of billets. In this process, high grade copper (over 99.90% pure) from Phelps Dodge's own mines is alloyed with the finest quality metals available. The alloys are melted in electric furnaces and cast in specially designed water-cooled molds that produce sound, homogeneous billets.

Each billet must conform to rigid Phelps Dodge standards, as well as to the requirements of ASTM and U.S. Government specifications. Strict control is maintained over every phase of the billet-casting operation.

Before melting, the metals to be alloyed are carefully weighed to their correct proportions in the cast billet. Each melt is carefully sampled for chemical and spectrographic analyses which verify the composition of the billet before it is released for further processing.

Throughout the entire tube fabrication—from raw materials to finished product—quality is the keynote. That's why Phelps Dodge tubes are preferred by those who demand the finest . . . the manufacturers and users of heat exchangers and condensers.

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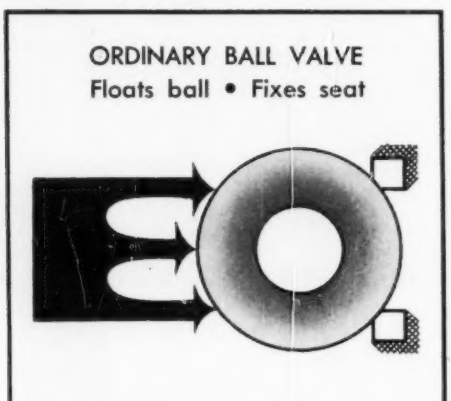

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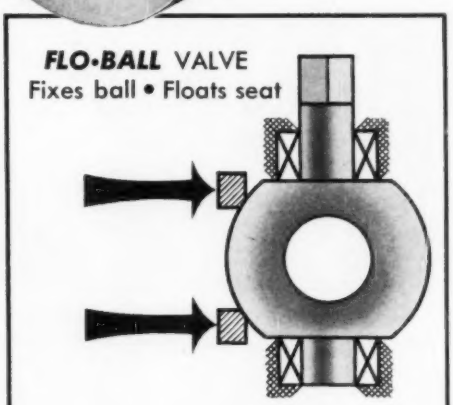

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ENDCOR – promotes rapid film formation . . . is completely stable against oxidizing agents.

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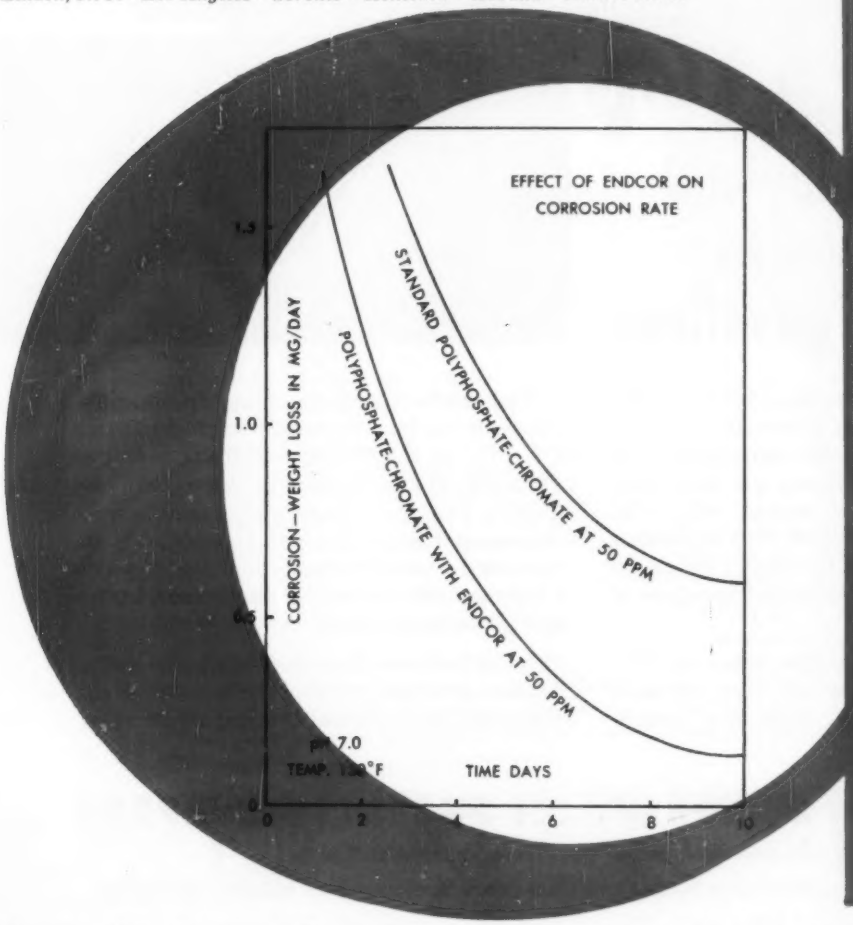

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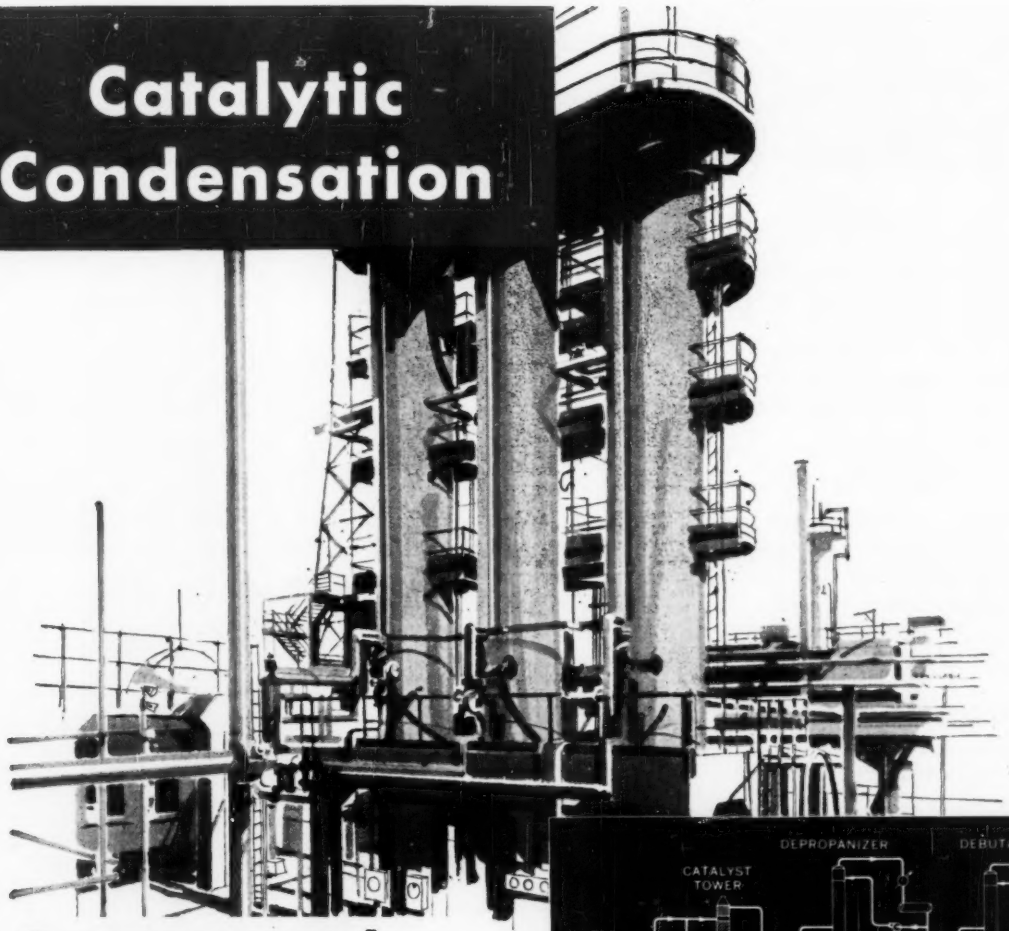

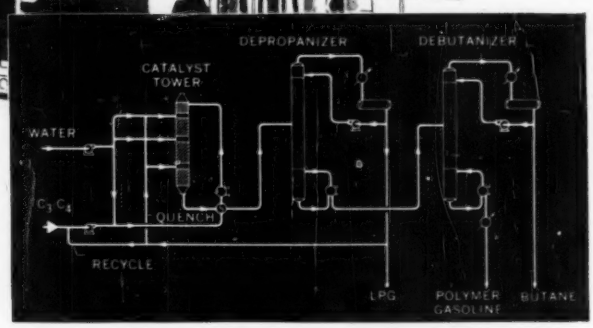

Converts propylene and butylenes to high-grade gasolines

This is another UOP process designed to help the refiner realize his greatest potential. Catalytic Condensation converts the propylene and butylene portions of refinery gas into high grade motor gasolines, by contact with UOP Solid Phosphoric Acid catalyst. Polymerization may be controlled to yield products which, on hydrogenation, produce saturated gasolines of high octane number.

Catalytic Condensation also offers an efficient means for producing specialty polymers of light olefins, for which there is a rapidly growing market for chemical use. For example, propylene can be polymerized to products rich in C_6, C_9, or C_{12} olefins, which are useful as raw materials for producing detergents and alcohols. The process may also be used to react ethylene and propylene with benzene to form, respectively, ethylbenzene for the production of styrene, and cumene for use in manufacturing acetone and phenol.

This is but one of many refining and petrochemical processes available from UOP. Write for process brochure and detailed information.

UNIVERSAL OIL PRODUCTS COMPANY

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More Than Forty Years Of Leadership In Petroleum Refining Technology

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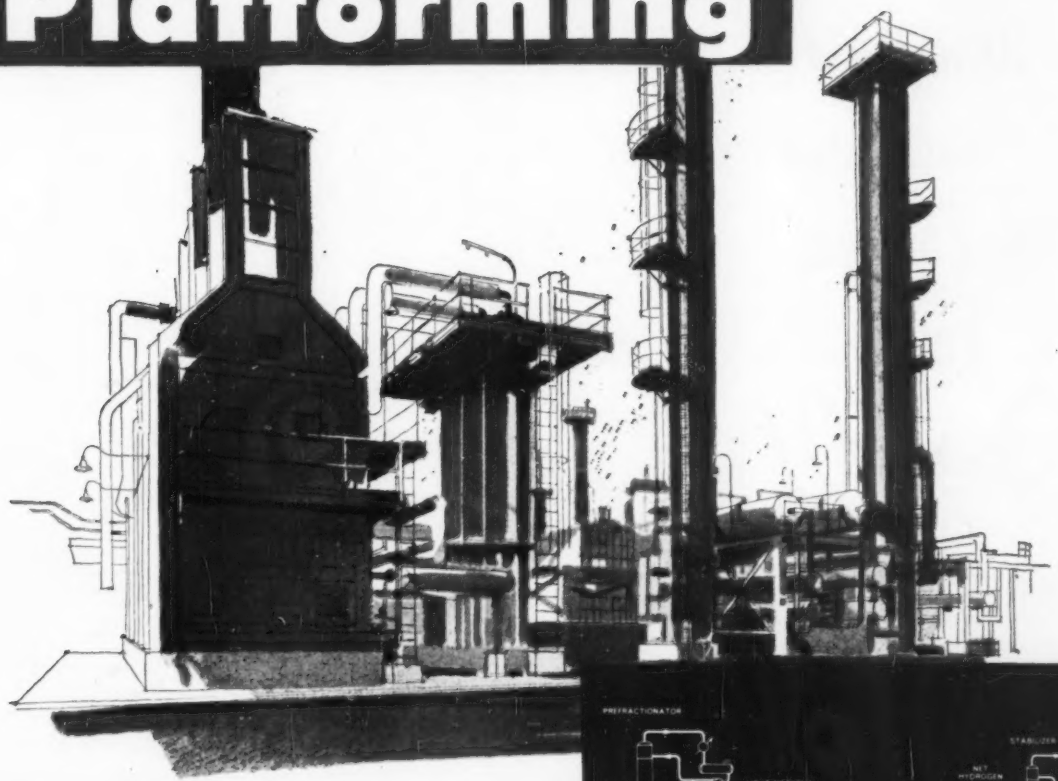

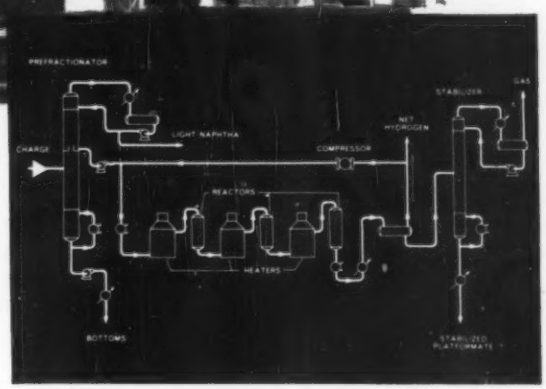

Produces high octane gasolines, high purity aromatics

No longer need low octane gasolines be a serious problem in refinery economics, thanks to the remarkably versatile refinery tool—UOP Platforming.

Inexpensive to install, easy to operate, reliable and safe, Platforming serves an important dual purpose: Using a platinum-containing catalyst which can operate for long periods without serious deactivation,—hence, expensive regeneration equipment is unnecessary—this practical process provides truly continuous production of superior quality motor fuel from straight run naphthas.

Equally important, it enables the refiner to produce in commercial quantities excellent base stocks for aviation gasoline and Platformate for aromatic extraction such as benzene, toluene and xylenes, now in such growing demand for detergents, nylon, plastics, high explosives and many other products.

As shown in the accompanying flow diagram, the Platformer is a compact unit consisting of a reactor section, stabilizer section, and (optional) feed preparation section. It can handle the full boiling range gasolines without prefractionation, or naphtha cuts separated from them, and efficiently processes any naphtha from crude distillation, natural gasoline plants or cracking units.

Platforming is but one of many UOP refining and petrochemical processes for improving refinery efficiency and producing more salable products. Available to refiners everywhere, these processes are illustrated and described in an informative new booklet. Write for your copy today. Address:

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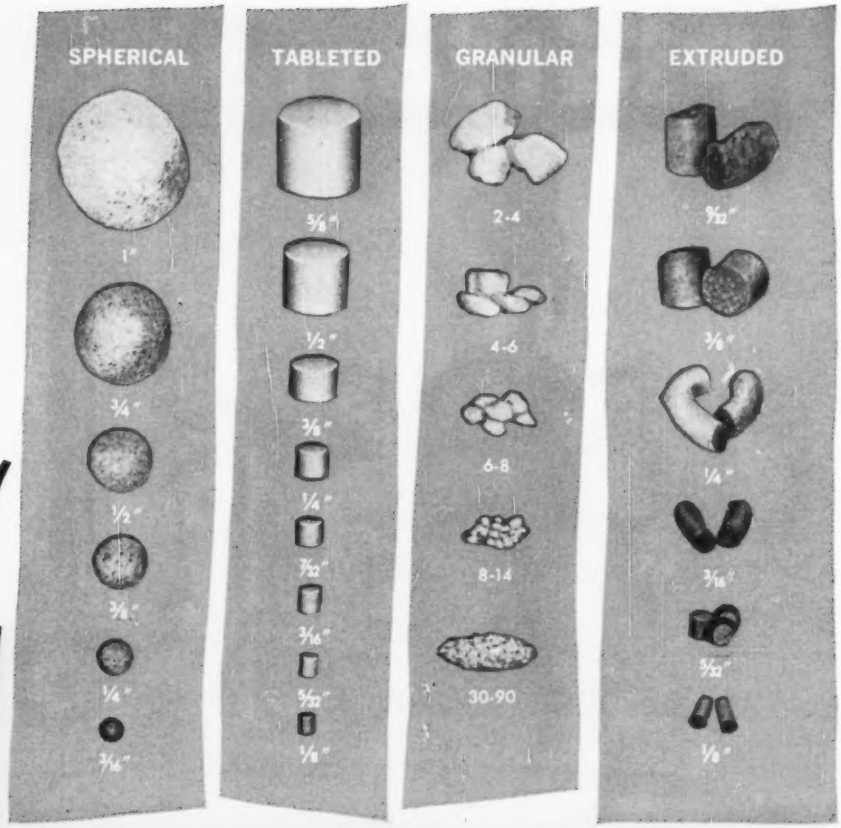

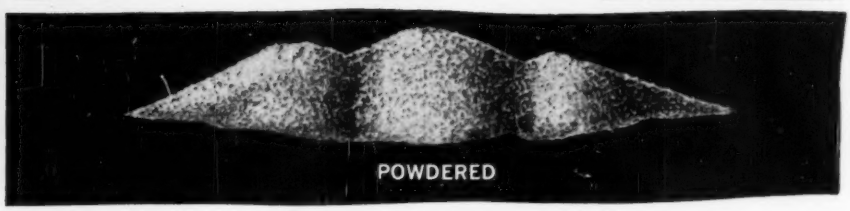

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Metallic Soaps (Cobalt, Manganese)		
Nickel Carbonate	Nickel Formate	Nickel Nitrate
Nickel Sulfate	Sodium Methoxide	Zinc Nitrate

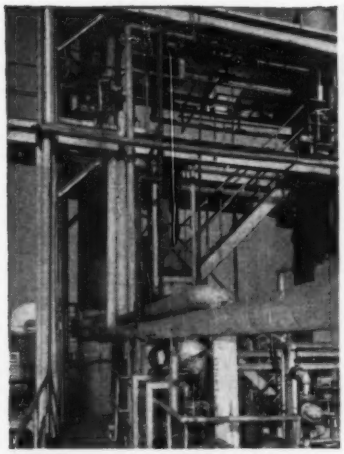
Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

THE HARSHAW CHEMICAL CO.

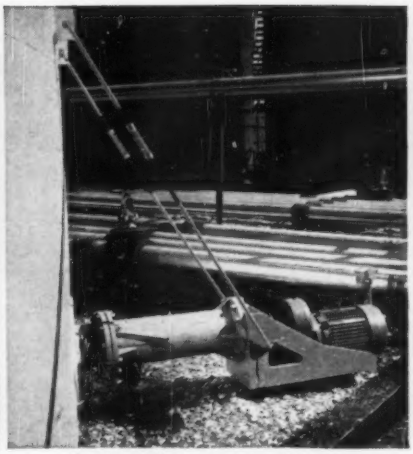
1945 EAST 97th STREET • CLEVELAND 6, OHIO

Chicago • Cincinnati • Cleveland • Detroit • Hastings-On-Hudson
Houston • Los Angeles • Philadelphia • Pittsburgh

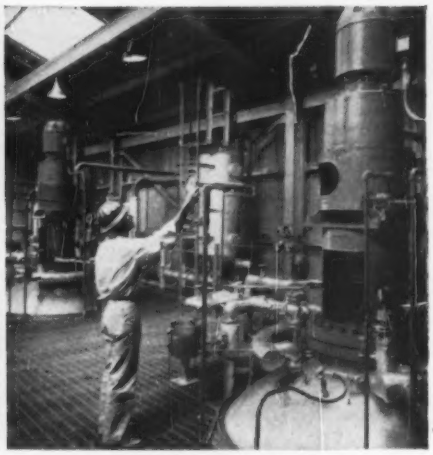
For more data on advertised products, use Readers' Service Cards, last page.



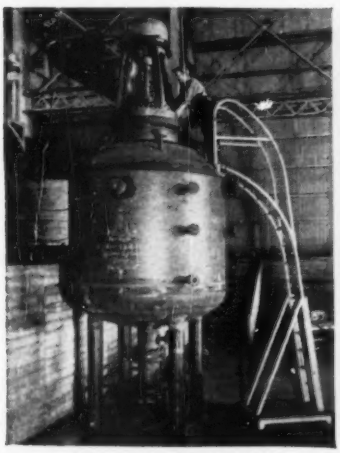
RDC Countercurrent Extraction Column Handling a Total Flow of 2500 GPH



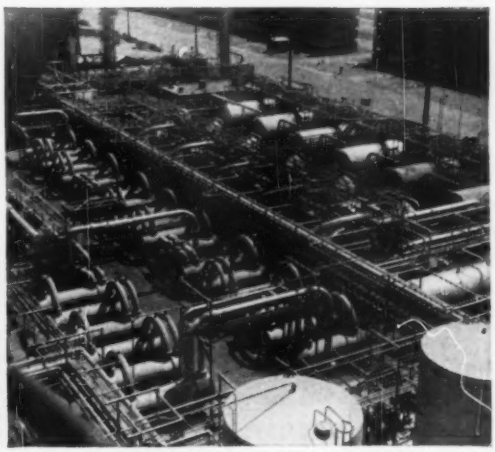
Side Entering Propeller Mixer Blending Asphalt Cutback Products



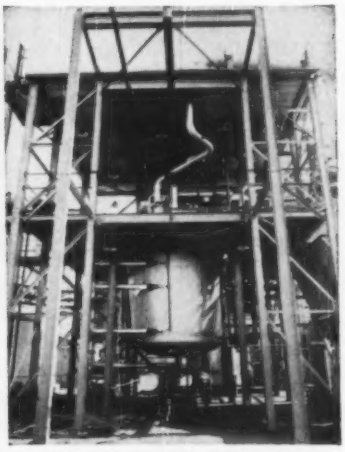
Typical Polyethylene Reactor Assembly



Three Stage Continuous Butane Isomerization Unit



Series of Three Stage Treaters and Settlers in CAA—Butadiene Extraction



7800 Gallon Outdoor Polyester Resin Reactor

for petrochemicals here is TURBO on the job

No mixing service is too large or too small for our staff of designers, engineers and skilled craftsmen, nor for the facilities of our plants. In support of the *high*-production, *low*-maintenance equipment shown here is more than 40 years of specialization in this field. Back of this equipment, too—a testing and research laboratory that enables our designers to custom-build Turbo-Mixers for *your* individual requirements.

Send for descriptive information showing how Turbo-Mixers can increase your production efficiency at lower cost.

FOR DETAILED INFORMATION AND USEFUL DESIGN DATA, SEND FOR THE FOLLOWING BULLETINS:

Please send me the following Turbo-Mixer Bulletin (s):

General Turbo-Mixer Bulletin_____

RDC Extraction Column Bulletin_____

Side Entering Propeller Mixer Bulletin_____

Absorption & Oxidation Bulletins_____

TURBO-MIXER GENERAL AMERICAN TRADE MARK

TURBO-MIXER DIVISION
GENERAL AMERICAN TRANSPORTATION CORPORATION

Sales offices: 380 Madison Avenue, New York 17, New York • General Offices: 135 South LaSalle Street, Chicago 90, Illinois • Offices in all principal cities

For more data on advertised products, use Readers' Service Cards, last page.

Dann Goodson, *Manager Motor-Driven Compressor Sales, The Cooper-Bessemer Corporation, explains...*

How Cooper-Bessemer's new, compact Air Compressors simplify installation and reduce costs

The DMR compressors shown here are two models of a new line of *compact, 720 rpm* machines, unmatched in reliability. With these units, Cooper-Bessemer introduces a new standard of installation economy. So highly compact, the DMR compressors are readily installed in existing space, avoiding the need for additional housing facilities. They can be located at strategic points throughout the plant to supplement existing air line services without additional feeders to help supply your production needs at minimum cost.

The new DMR units come completely equipped with integral motor-drive and intercooler... ready for operation. Their control can also be integrally mounted as shown. They are available for two-stage applications in the range of 500 to 2000 cfm and discharge pressures of 80 to 125 psi... also for single-stage and three-stage operation.

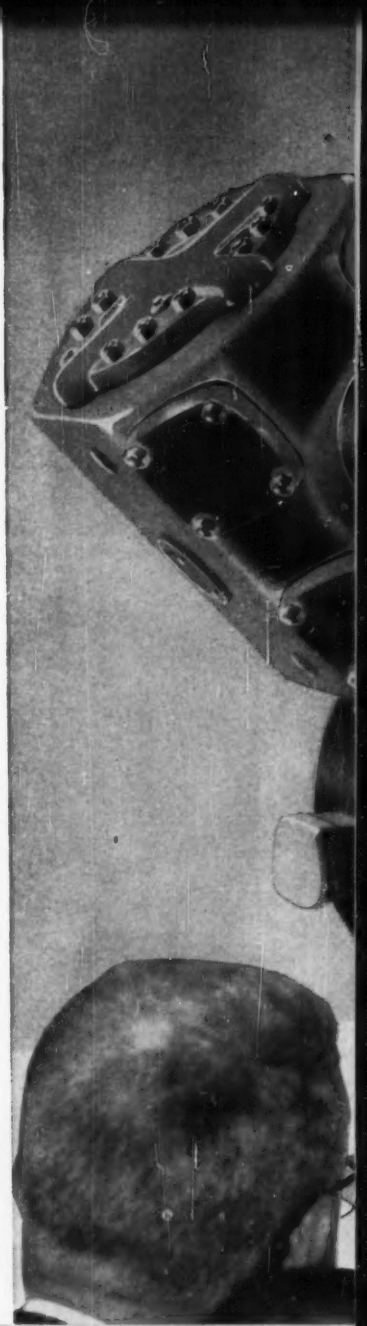
The introduction of this new line of air compressors, plus the portable tool facilities of our new subsidiary, The Rotor Tool Company, enable Cooper-Bessemer to give you full-scope service for your industrial air power needs. Call the nearby Cooper-Bessemer office or air compressor agent for Bulletin No. 94 on the new DMR line.

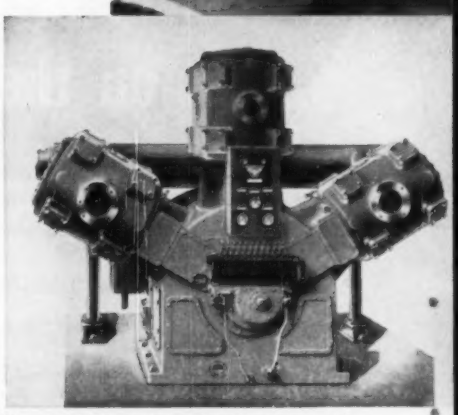
BRANCH OFFICES: Grove City • New York • Washington • Gloucester • Pittsburgh
Chicago • Minneapolis • St. Louis • Kansas City • Tulsa • New Orleans • Shreveport
Houston • Greggton • Dallas • Odessa • Pampa • Casper • Seattle • San Francisco
Los Angeles
SUBSIDIARIES: Cooper-Bessemer of Canada, Ltd.... Edmonton • Calgary
Toronto • Halifax
C-B Southern, Inc.... Houston
Cooper-Bessemer International Corporation... New York • Caracas • Anaco
Cooper-Bessemer, S.A.... Chur, Switzerland • The Hague, Netherlands • Mexico City
The Rotor Tool Company... Cleveland

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS • DIESEL • GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL,
ENGINE, TURBINE OR MOTOR DRIVEN

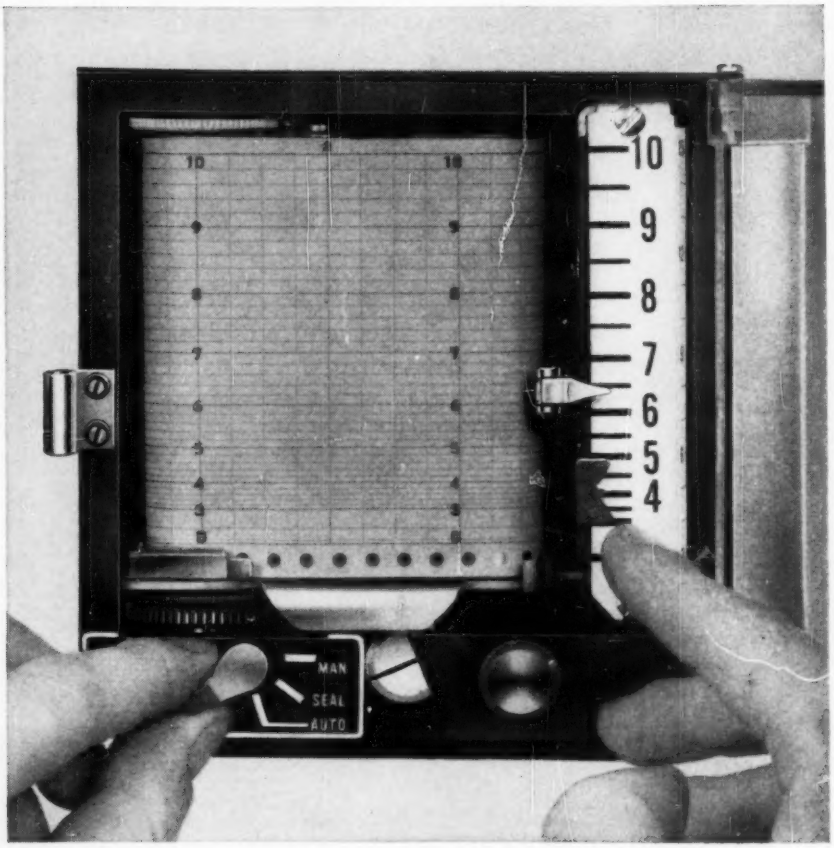




New DMR-3 two-stage air compressor with integral control. Ratings of 300-350 hp.

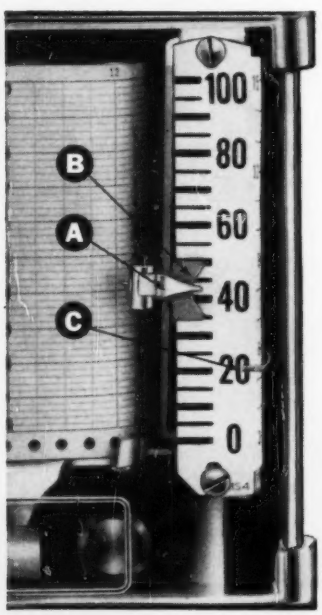
NEW
COOPER-BESSEMER
DMR-2 TWO-STAGE
AIR COMPRESSOR
WITH
EN-TRONIC CONTRO
100 TO 250 HP

One of 38 Metagraphic Receiver Models you can choose from, all with only 5" x 5⅛" panel. This model has single-knob, six-position transfer station for completely "bumpless transfer" in cascaded control systems.



BRISTOL METAGRAPHIC RECEIVERS:

"Easiest 'bumpless transfer' you ever saw"



Variable (A), set point (B), and valve position (C), all on same scale, make manual-automatic transfer easy.

That's what instrument men say after trying the Bristol Metagraphic Pneumatic Receiver—even in cascade control systems.

Just seal, match pointers, transfer. There's not a single value to read. That's because the Metagraphic gives you valve position, set point and measured variable *—all on the same scale.*

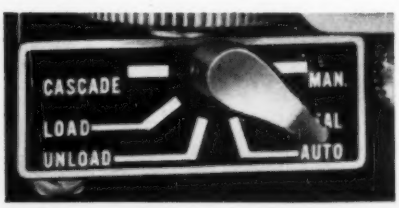
No finger-disconnects here! The Metagraphic is a true plug-in receiver—plugs and unplugs in 5 seconds with no loss of automatic control.

You can switch from indicator to recorder in less than 10 seconds, interchange many receiver models, change range simply by changing chart. Cuts down on costly reinstallations if process requirements are changed.

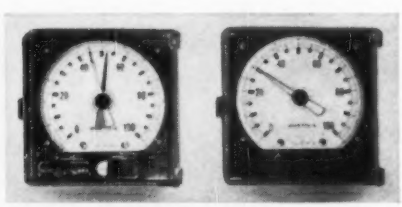
Write today for the complete Metagraphic story. Don't forget, Bristol offers the widest selection of miniatures on the market. (Full sized instruments, too.) The Bristol Company, 111 Bristol Road, Waterbury 20, Conn. B-18

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



Six-position transfer station (enlarged view) for cascade service. Three-position manual-automatic station is also available.



Metagraphic Indicating Receivers have full 9-inch scale for easy reading; feature complete 10-second interchangeability with recorders.

For more data on advertised products, use Readers' Service Cards, last page.

* Practically Perfect!

HUMBLE COREXIT

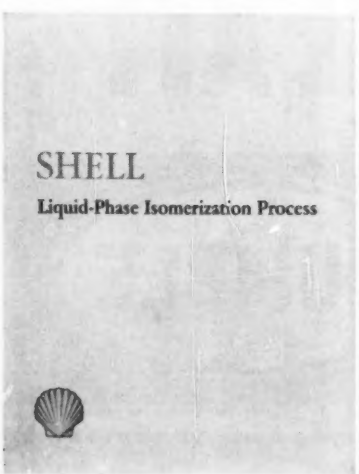
Save time and money previously lost to internal corrosion: use Humble COREXIT . . . COREXIT effectively and economically prevents internal corrosion in pipe still overhead, distillation towers, vapor recovery systems and other refining units. COREXIT will reduce or completely eliminate plugging or fouling. This protection against sludge, scale and corrosion cuts non-productive downtime to a minimum. For complete information on technical services and products, contact your Humble salesman.

HUMBLE

HUMBLE OIL & REFINING COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

Shell's unique LPI* Process isomerizes both C_4 and C_5 at industry's lowest cost



Shell's *Liquid-Phase Isomerization Process is completely described in this new book. Send now for your free copy to Shell Development Company, 50 West 50th Street, New York 20, New York.

SHELL

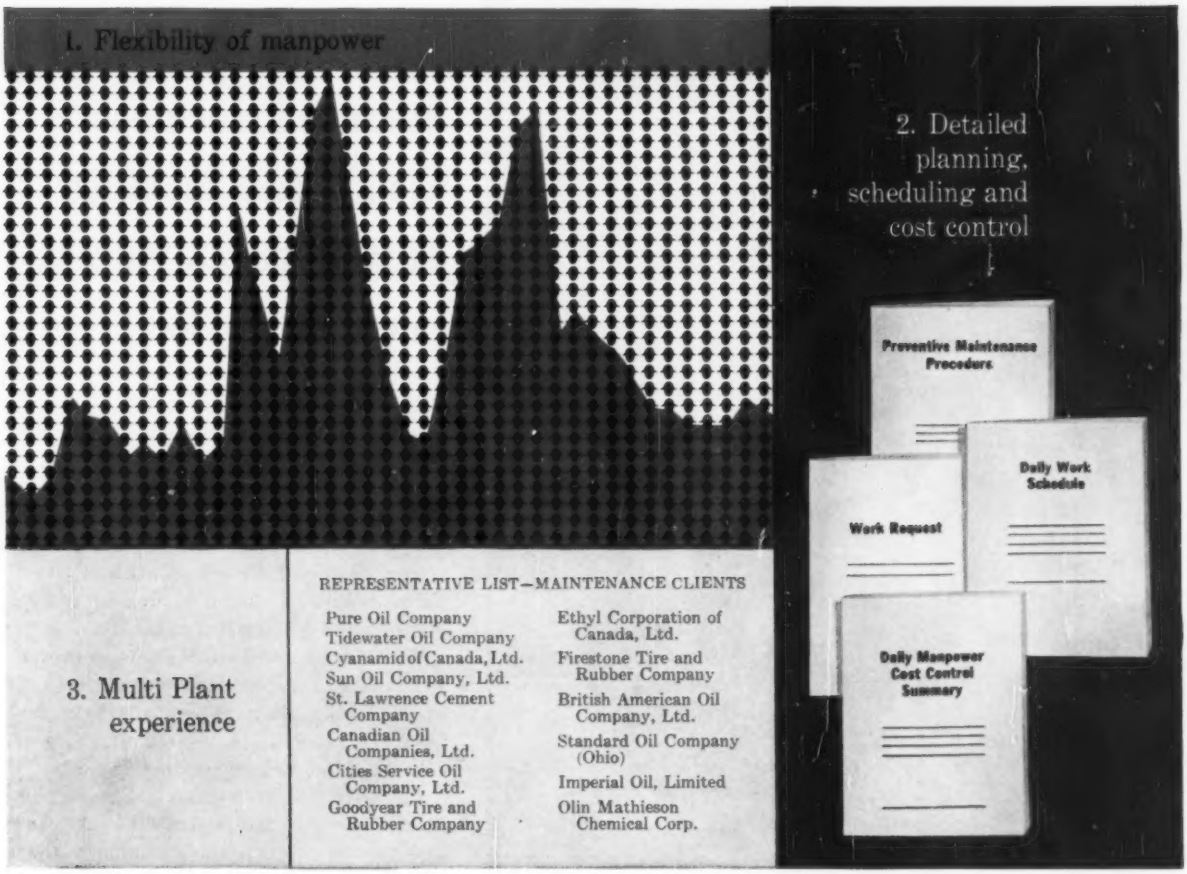
LPI process licensed only by

SHELL DEVELOPMENT COMPANY

A Modern Concept of Maintenance

MAINTENANCE BY CONTRACT

reverses the current trend toward higher maintenance costs this way . . .


1. Flexibility of manpower
2. Detailed planning, scheduling and cost control
Preventive Maintenance Procedure
Daily Work Schedule
Work Request
Daily Manpower Cost Control Summary
3. Multi Plant experience
REPRESENTATIVE LIST—MAINTENANCE CLIENTS
Pure Oil Company
Tidewater Oil Company
Cyanamid of Canada, Ltd.
Sun Oil Company, Ltd.
St. Lawrence Cement Company
Canadian Oil Companies, Ltd.
Cities Service Oil Company, Ltd.
Goodyear Tire and Rubber Company
Ethyl Corporation of Canada, Ltd.
Firestone Tire and Rubber Company
British American Oil Company, Ltd.
Standard Oil Company (Ohio)
Imperial Oil, Limited
Olin Mathieson Chemical Corp.

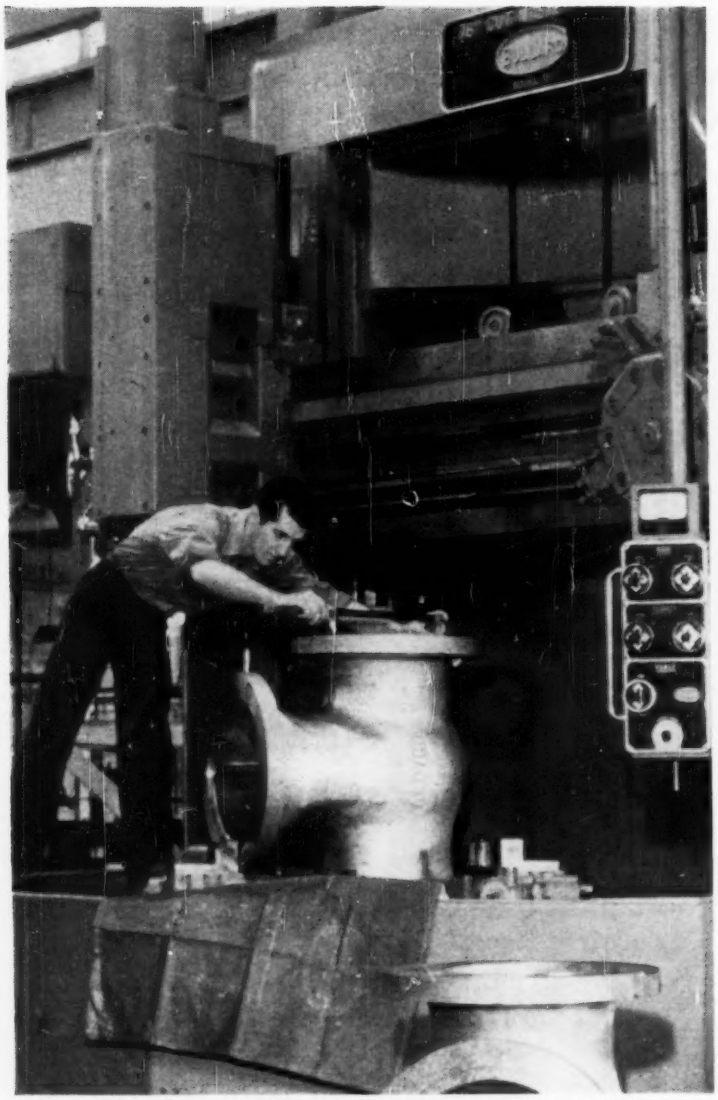
Contract Maintenance is a modern professional management service offering complete flexibility in manpower, tools, equipment and supervision. Catalytic contract maintenance is backed up by an experienced technical and supervisory staff. Control of all aspects of the maintenance program and manpower requirements remain with the client. For details of the advantages and economies of contract maintenance in brochure form contact—

CATALYTIC
CONSTRUCTION COMPANY

Philadelphia 2, Pennsylvania
New York, New York
Baton Rouge, Louisiana
Toledo, Ohio
In Canada: Catalytic Construction of Canada, Limited; Sarnia, Ontario; Toronto, Ontario; Montreal, Quebec.

Catalytic *On-Time . . . On-Budget* Service for the metallurgical, chemical, petrochemical and oil refining industries: Project Analysis; Process Development; Process Design; Economic Studies; Engineering; Procurement; Construction, and Contract Maintenance.

For more data on advertised products, use Readers' Service Cards, last page.



14" 300 lb. gate valve slated for a large petro-chemical plant, is being worked on one of Aloyco's battery of new Bullards.

Advanced machines... tools...test facilities expand Aloyco Valves' range of service

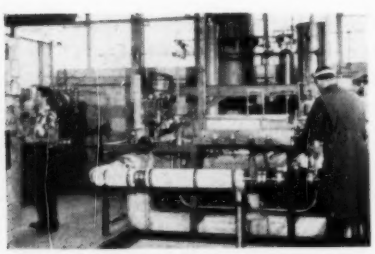
Constant change and improved techniques in modern fluid handling, pose a real challenge for valve manufacturers.

To meet these demands, Aloyco is constantly adding new facilities, some of which are pictured here.

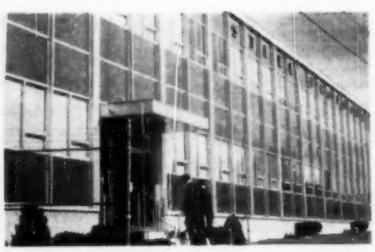
For example, Aloyco Stainless Steel Valves are now available in sizes up to 24", pressures up to 2,500 lbs. at 650°F.

While these new facilities have improved and expanded the quality and usefulness of our entire line, they are particularly important, for example, in the manufacture of valves for the nuclear and missile fields.

For advanced knowledge and ideas plus the equipment to carry them out – take your next valve problem to the specialists: Alloy Steel Products Company, 1303 West Elizabeth Avenue, Linden, New Jersey.



One of finest hot test loops in the nation checks out valves at up to 2500 psi, 650°F. Hot tests can spot trouble that would otherwise be revealed only after months of line service.



New multimillion dollar Aloyco plant combines new production tools, test facilities, sales, administration, research and development offices and labs into single integrated unit.

Boroscope examination (in pressurized clean room) of specially made nuclear valves follows the application of dye penetrant.

ALLOY STEEL PRODUCTS COMPANY

LINDEN, NEW JERSEY

Boston • New York • Wilmington • Atlanta • Birmingham • Baton Rouge • Buffalo
Pittsburgh • Chicago • St. Louis • San Francisco • Los Angeles • Seattle

For more data on advertised products, use Readers' Service Cards, last page.

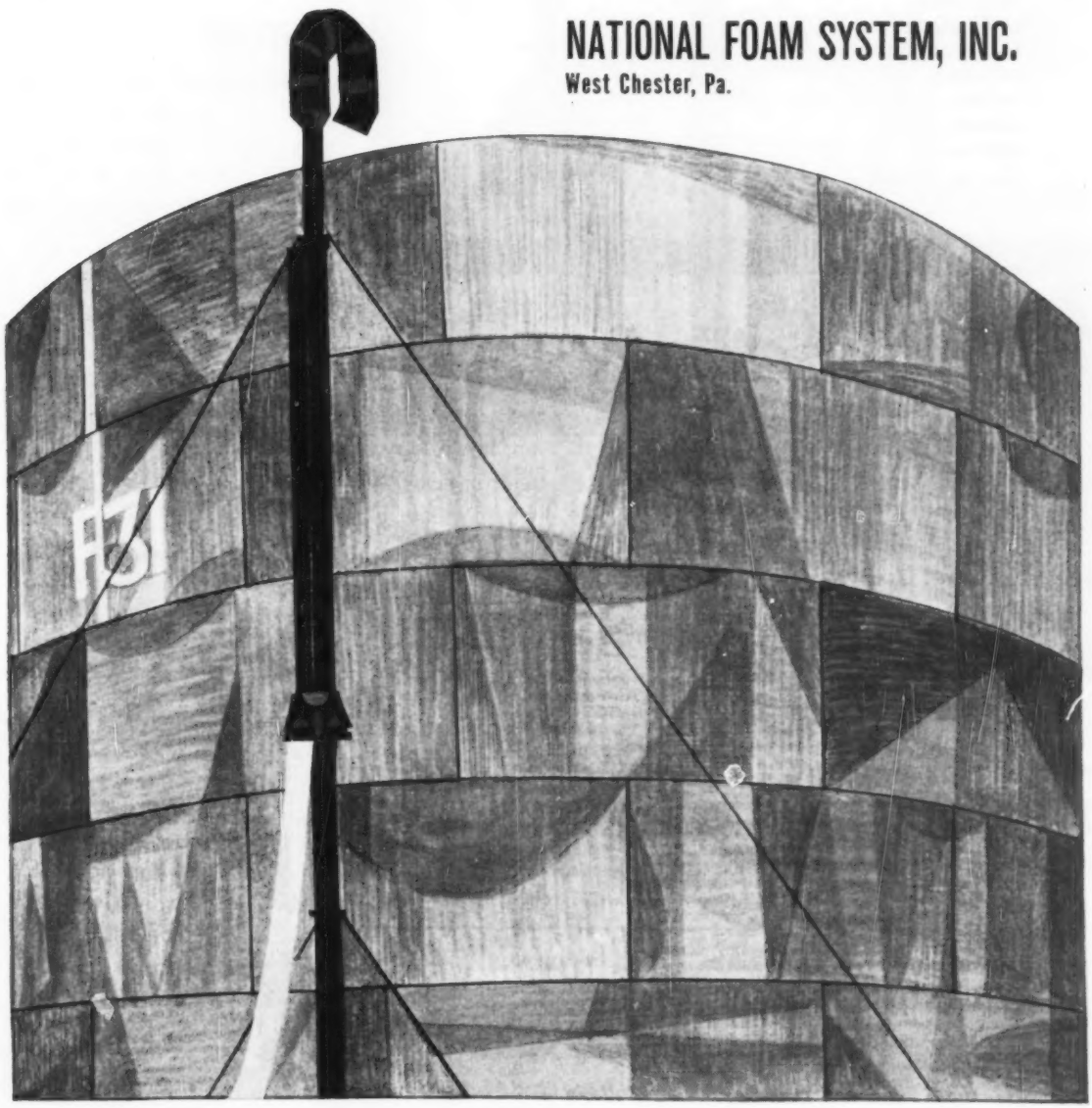
do your foam towers measure up to these standards?

1. Are they built to withstand extreme rough treatment? ☐ Yes ☐ No
2. Would you feel confident in a high wind? ☐ Yes ☐ No
3. In the emergency, can you handle mechanical or chemical foam with the same gooseneck, without requiring "extras" for this purpose? ☐ Yes ☐ No
4. If yours are the "detachable" type of gooseneck, can you accomplish the "detaching" operation without having personnel beneath it, where they might be struck if the gooseneck dislodges and falls? ☐ Yes ☐ No
5. Are your goosenecks of heavy gage stainless steel, built to take the high heats of a flammable liquid fire? ☐ Yes ☐ No

If you can answer yes in all cases, you already have National Aer-O-Foam Towers. If not, you need them! For full information, write for Booklet G.

NATIONAL FOAM SYSTEM, INC.

West Chester, Pa.



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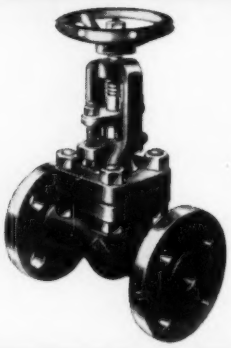
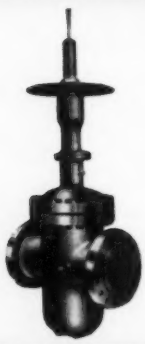


Are you ✳ **COST CONSCIOUS?**

WEDGE GATE
GLOBE
PIPE LINE
LINE BLIND
LUBRICATED PLUG
DOUBLE DISC
PARALLEL SLIDE
CHECK
ANGLE
and many other types



QUALITY:

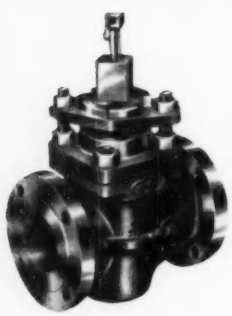
A very wide range of high quality valves in Cast Carbon Steel, Drop Forged Steel, Stainless and Alloy Steels to American specification.

SERVICE:

Immediate delivery and full advisory service.

PRICE:

You may be *valve* conscious, but are you *cost* conscious? You can save dollars on each installation. Call us and have us show you how.



✳ You may not be aware how much you might save by using Triangle valves—which are in world wide use in refineries and oil fields. We'd *like* you to know—why not have us call?

We're only a telephone call away
Murray Hill 8-0910

PRODUCTS OF THE

TRIANGLE VALVE CO. LTD.

315 REGENT STREET, LONDON, W.1, ENGLAND. *Cables: TRIVALON LONDON*

Europe's largest manufacturers of steel valves for the oil and chemical industries.

SOLE AGENTS IN THE UNITED STATES:

FRANKLIN SUPPLY CO.

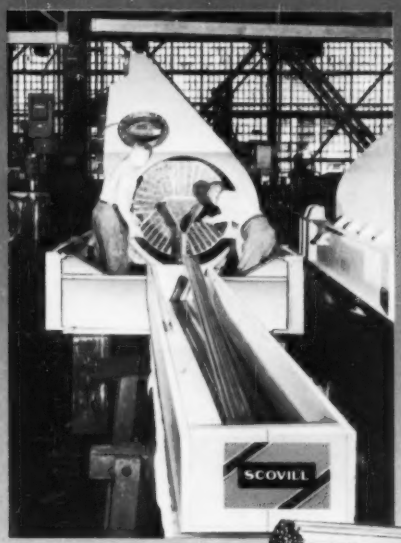
375 PARK AVE., NEW YORK CITY 22, NEW YORK
Murray Hill 8-0910

EUROPE'S LARGEST MANUFACTURERS OF STEEL VALVES FOR THE OIL AND PETROLEUM INDUSTRIES

TVB

For more data on advertised products, use Readers' Service Cards, last page.

where trouble-free performance is a matter of national security



each of newest **NUCLEAR SUBS** will take aboard more than **4 MILES** of Scovill cupro-nickel, 30% heat exchanger tube

SCOVILL

We're proud to be making this important contribution to the long-service dependability of these nuclear-powered submarines.

Like all other components of their nuclear-powered propulsion machinery and equipment, the Foster Wheeler main condensers, shown above being tubed with Scovill Cupro-Nickel, 30% Heat Exchanger Tube, have passed the most exhaustive performance tests it has been possible to devise. The same tube specification is also being installed in the ejector condensers. All of the tube is electronically tested on new equipment at the Scovill Tube Mills before delivery.

Scovill Cupro-Nickel, 30% Heat Exchanger Tube has a long record of trouble-free service on U. S. Naval vessels and those of many other nations. It is a first choice of design and operating engineers where salt water or corrosion conditions are severe, particularly at elevated temperatures and when the circulating media travel at high velocities. The corrosion resistance is excellent; strength of the alloy remains constant over a wide temperature range.

Why not discuss your own heat exchanger tube conditions and problems with Scovill Technical Service . . . considered by many the most experienced in the field.

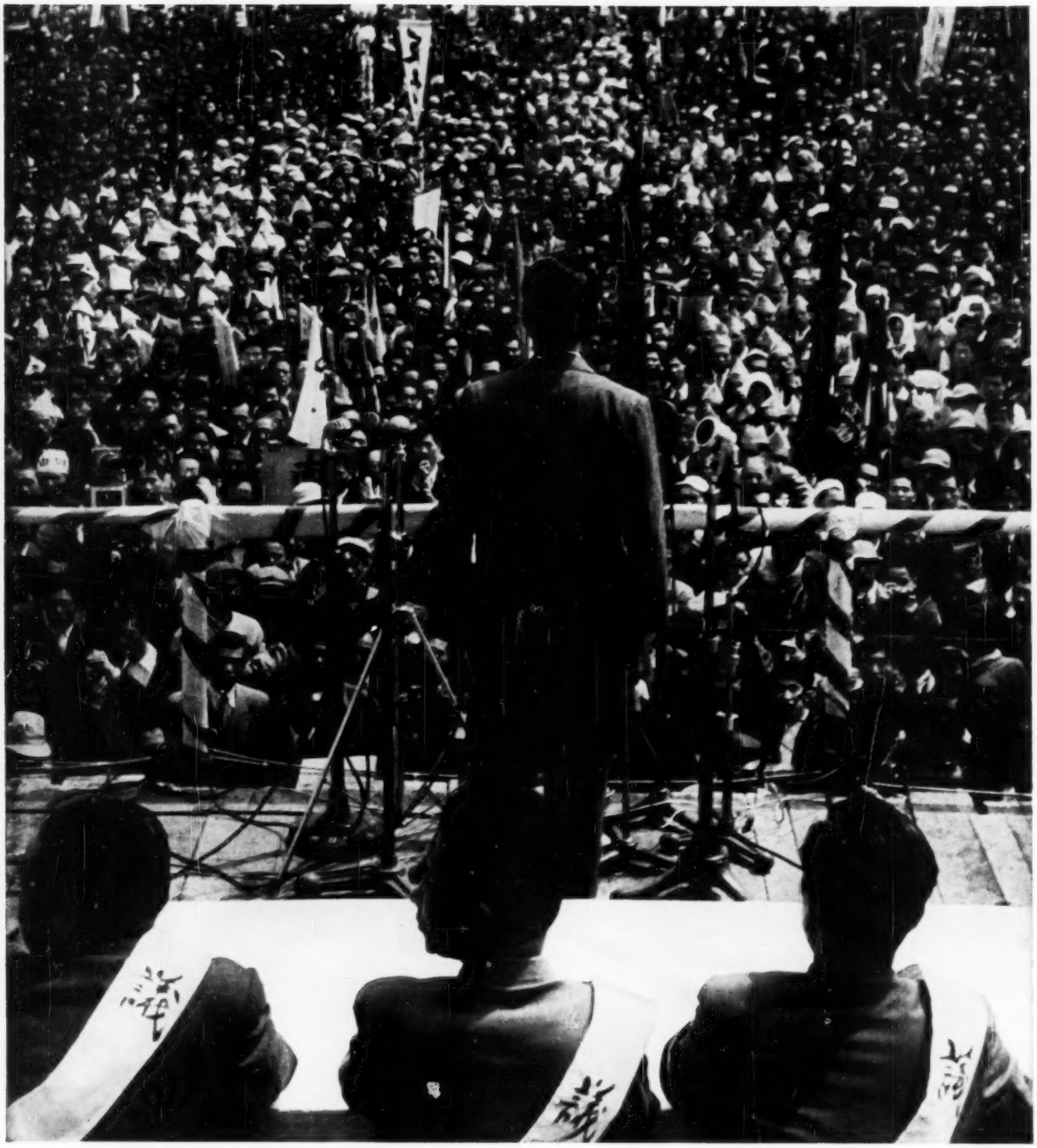
HEAT EXCHANGER TUBE

for Applications from Marine to Petrochemical, from Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys . . . Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Cupro-Nickel, 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube.

SCOVILL MANUFACTURING COMPANY, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY ★★★★★★★

18SC59

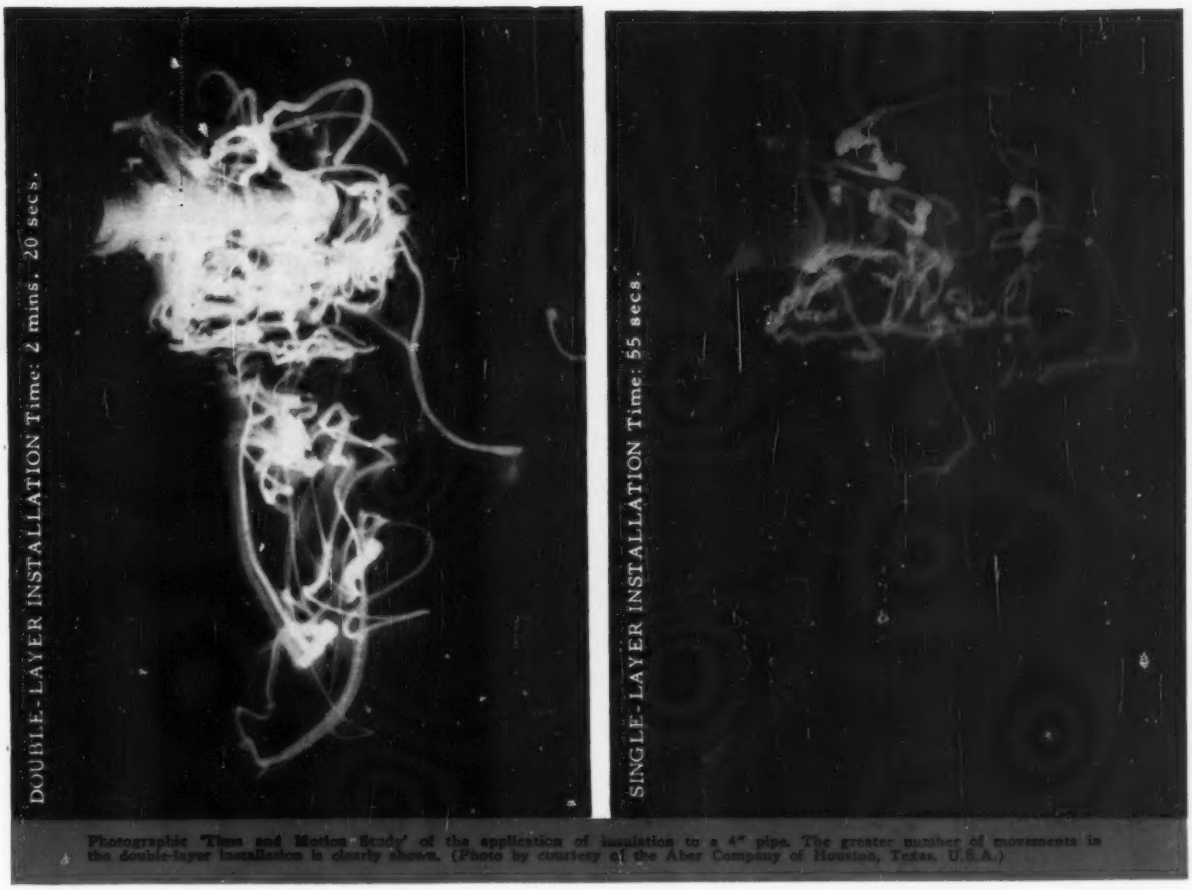


"The time when we could attend to our local affairs without reference to international events is long past. Such upheavals as the revolution in technology, the explosion of population, the awakening of Asia and Africa, will gather pace and power. The question is: are we capable of adapting ourselves to them? Here is the real contest between Communism and our own system. Which will be most responsive to the inexorable demands of the world as it is and as it will be?" —Eugene Holman, Chairman of the Board

Standard Oil Company (New Jersey)

and affiliated companies

For more data on advertised products, use Readers' Service Cards, last page.



Photographic 'Time and Motion Study' of the application of insulation to a 4" pipe. The greater number of movements in the double-layer installation is clearly shown. (Photo by courtesy of the Aber Company of Houston, Texas, U.S.A.)

One layer— Less work

CAPOSITE single-layer insulation

Insulation in a single layer! Caposite was developed by The Cape Asbestos Company to avoid the 'two-layer compromise' Caposite does it in one—saving considerably on installation time and costs. Caposite, the amosite asbestos insulation, is designed to withstand temperatures up to 1000° F. without loss of efficiency.

LOW JOINT LOSS

The fibrous edges of Caposite knit together at the joints giving a good heat seal and making staggered joints unnecessary.

EASY TO HANDLE

Its inherent strength makes it possible to handle Caposite in large sections for example at 2" thick for 30" n.p.s.—with very little damage and a further saving in installation costs.

CAPE

THE CAPE ASBESTOS COMPANY LIMITED 114 & 116 Park Street, London W. 1, Grosvenor 6022
Cables: Incorrupt London

Enquiries in Canada to: Cape Asbestos (Canada) Limited, 200 Bloor Street East, Toronto, Ontario.
U.S.A.: North American Asbestos Corporation, Board of Trade Building, Chicago 4, Illinois.

TA 2543

For more data on advertised products, use Readers' Service Cards, last page.

FLUOR COOLING TOWERS

higher thermal performance

lower maintenance cost

built-in permanence

etc. *

*The et ceteras make profitable reading. Would you like a free copy of our catalog that describes in detail the designed quality of Fluor towers?

Fluor PRODUCTS COMPANY
INDUSTRIAL COOLING TOWERS

A division of The FLUOR CORPORATION, Ltd.

GENERAL OFFICES:
SANTA ROSA, CALIFORNIA

For more data on advertised products, use Readers' Service Cards, last page.

The customer who thought he got something special

A Gulf Coast oil refiner was in a hurry to build a new catalytic platformer. He needed a special analysis of seamless steel tubing—delivered from the mill in just the exact size and length. But, the refiner was afraid he wouldn't get the steel on time.

A team of Timken Company experts tackled the problem. They got the steel out on time—so fast that the refiner thought he received special treatment.

And he did—the very same special, individual treatment we're geared to give *every* customer—and do!

This order was routine for our team of metallurgical-production-operating people. Special jobs are right down their alley because they have the know-how and the facilities. You can call ours a tailored operation—but it's really more. The steel was babied all the way. Every modern quality control device kept an eye on the steel all through the melting, rolling, piercing, finishing. It passed every inspection for surface, size and quality and there wasn't a minute's delay. That's the kind of special treatment that's made the Timken Company a leading producer of special quality fine alloy steel.

If you want your steel to receive special treatment, give your next order to the Timken Company, where *every* order is special. And for help in solving your steel problem, consult our metallurgists. They've probably solved a problem similar to yours dozens of times.

The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

For more data on advertised products, use Readers' Service Cards, last page.

DE LAVAL

CENTRIFUGAL COMPRESSORS

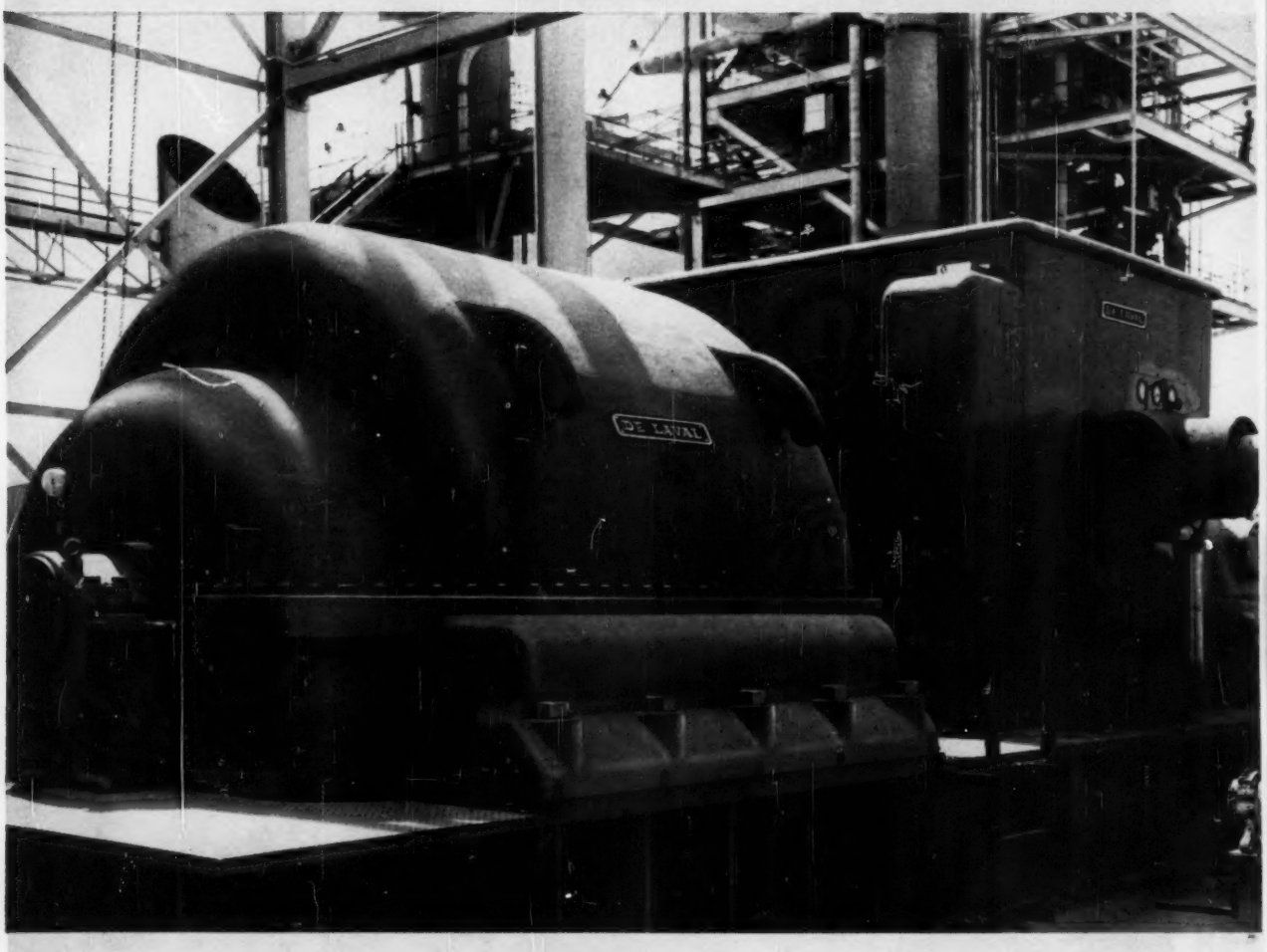
11,300

Driven by automatic extraction steam turbine

Shown below is the large 11,300 horsepower centrifugal blower which compresses air for the main blower service in catalyst regeneration at Standard Oil of Ohio's new refinery at Toledo, Ohio.

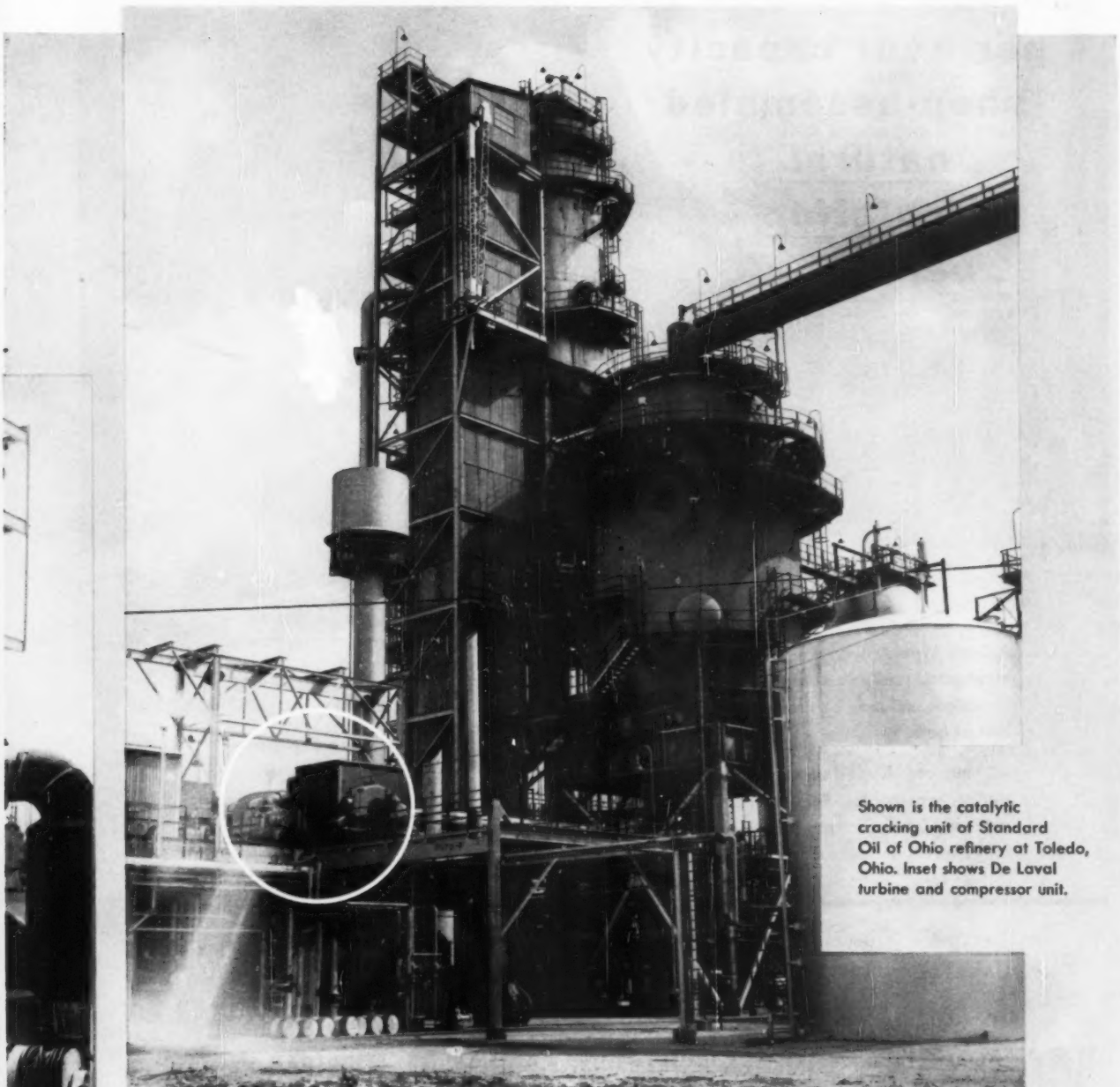
Driven by a De Laval single automatic extraction steam turbine, it compresses 110,300 cfm in four stages at 2800 rpm. Inlet pressure is 14.7 psia and discharge pressure is 40.7 psia. The turbine is designed for 600 psig ISP, 740F extracting at 55 psig, and exhausting to 28" Hg.

This is another example of De Laval proved performance.



DL-437

horsepower DE LAVAL compressor for "cat cracker" at SOHIO refinery



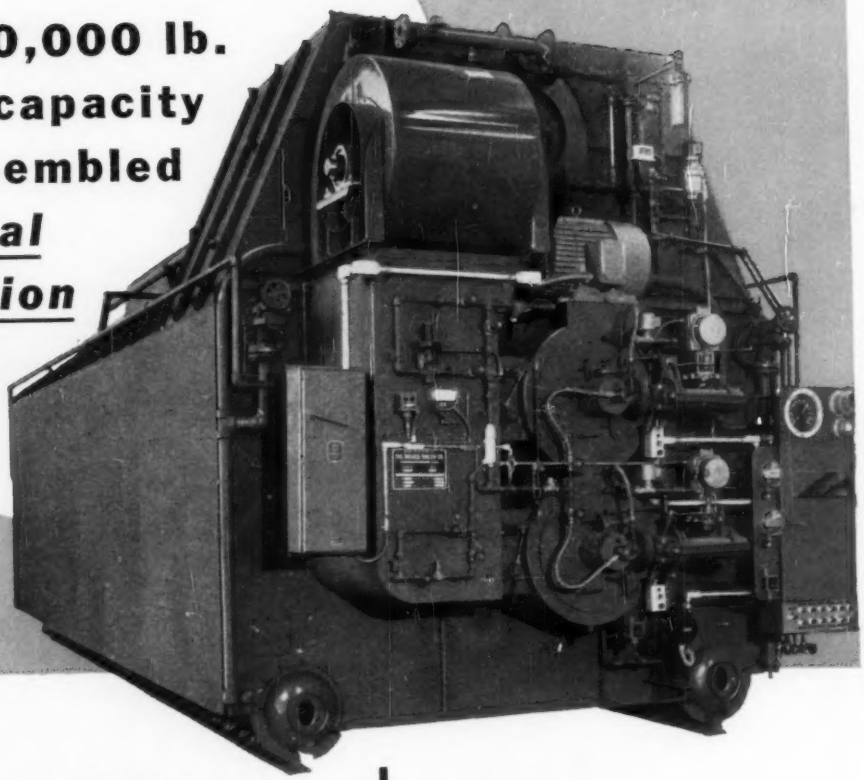
Shown is the catalytic cracking unit of Standard Oil of Ohio refinery at Toledo, Ohio. Inset shows De Laval turbine and compressor unit.

DE LAVAL *Steam Turbine Company*

811 NOTTINGHAM WAY, TRENTON 2, N. J.

...now from WICKES

a new 100,000 lb. per hour capacity shop-assembled *natural circulation* boiler



Wickes Type A units are of simple design, ruggedly constructed and adaptable to a variety of operating conditions and may be fired with oil, gas or combination of both.

All units are shipped completely shop-assembled including superheater, fuel burning equipment, safety and combustion controls, forced draft fan and drive, soot blowers and feedwater regulator.

Save on

- **First Cost**
- **Operating Expense**
- **Space**
- **Delivery Time**
- **Installation Time**

For more detailed information on Wickes Type-A steam boilers, write for our catalog 56-1. Bulletin 55-1 covers the complete line of Wickes Products and Facilities.

WICKES type A

WICKES

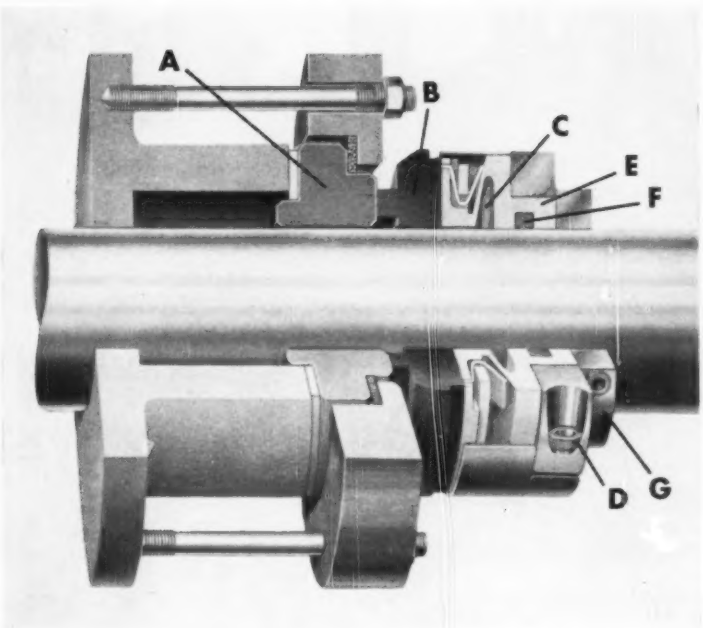
WICKES BOILER CO., SAGINAW 18, MICHIGAN

DIVISION OF THE WICKES CORPORATION

RECOGNIZED QUALITY SINCE 1854 • ***SALES OFFICES:*** Boston • Chicago • Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • New Orleans • Portland, Ore. • Saginaw • San Francisco • Springfield, Ill. • Tulsa.

169-R

ENGINEERED SEALS
for Petroleum Refining



LAST LONGER IN CORROSIVE CHEMICALS

Garlock CHEMISEAL* Mechanical Seals have, through years of application, proved their ability to seal effectively against all chemicals . . . from the "easier" Methanol, Acetic and Propionic Acids to the more reactive Hydroxyacetic, Sulfuric, Adipic Acids and Hydrocarbon Slurry.

High-quality construction. The bellows unit of CHEMISEAL Mechanical Seals is, in all cases, made of chemically-inert Teflon†. Various materials are used for the sealing faces dependent upon the medium and service requirements. Referring to the illustration at left, the seal comprises a stationary face "A" secured to the stuffing box and a rotary face "B" which rotates with the balance of the seal mechanism and is secured to the shaft. Between these precision lapped faces a leak proof seal is accomplished by the spring loaded Teflon bellows section "C." Clamp "D" secures area "E" to the shaft with the help of the Hypalon or Teflon O-Ring "F," forming a drop-tight seal. Back-up collar "G" is an added precaution to prevent the seal from working out on the shaft.

There are other benefits, too, that CHEMISEAL Mechanical Seals can add to your particular application. Consider the fact that they offer a life expectancy many times that of other seals . . . don't score the shaft during operation . . . are easy to handle and install.

Solve your difficult sealing problems. Apply Garlock CHEMISEAL Mechanical Seals against all media—including solids in suspension—in pressures to 100 psi at 75°C, or 75 psi at 100°C. Standard sizes to fit all pump shafts from $\frac{7}{8}$" to $2\frac{1}{8}$"; special sizes also available. Discuss complete details with your local Garlock representative, or write for Catalog AD-164. The Garlock Packing Company, Palmyra, New York.

GARLOCK

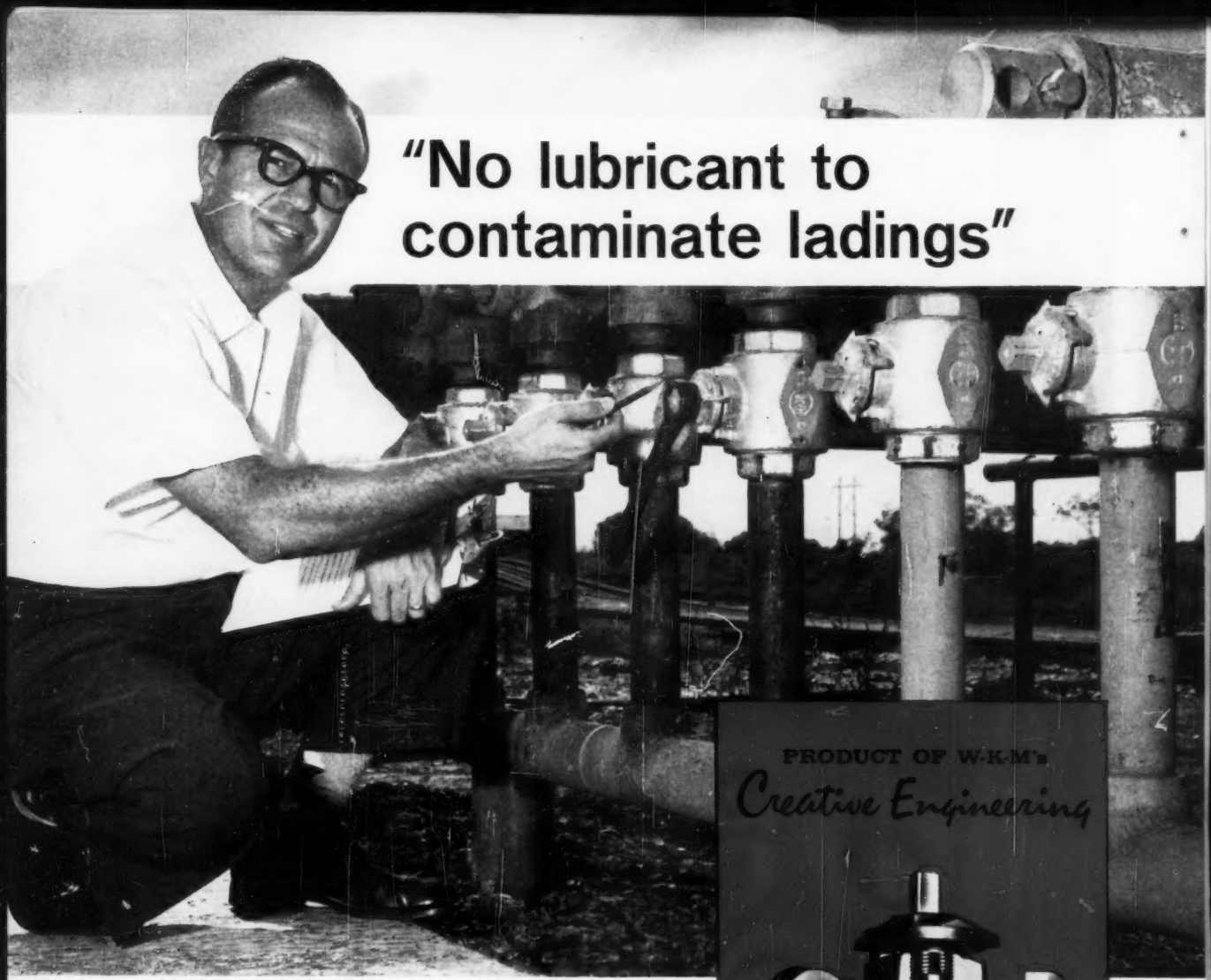
Canadian Div.: The Garlock Packing Company of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

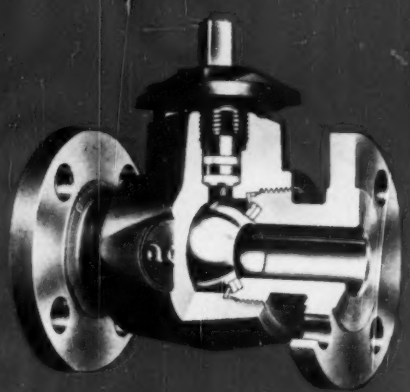
*Registered Trademark
†DuPont Trademark for TFE Fluorocarbon Resin

For more data on advertised products, use Readers' Service Cards, last page.



"No lubricant to contaminate ladings"

PRODUCT OF W-K-M's *Creative Engineering*



acf® non-lubricated Ball Valves

ACF Ball Valves are specially designed for ladings that require absolute purity. There is no lubricant, no possibility of contamination. The chrome-plated ball is suspended between Teflon seats under compression for leakproof sealing.

A quick quarter-turn operates this rugged valve. Specify it. You'll get efficient, economical performance. *Available at leading supply stores everywhere.*

Service-proved for 5½ years with such ladings as: gasoline • alkalis • liquefied petroleum gases • acetone • synthetic fuels • paint solvents • toluol • alcohol.

WRITE FOR CATALOG 1000

W-K-M

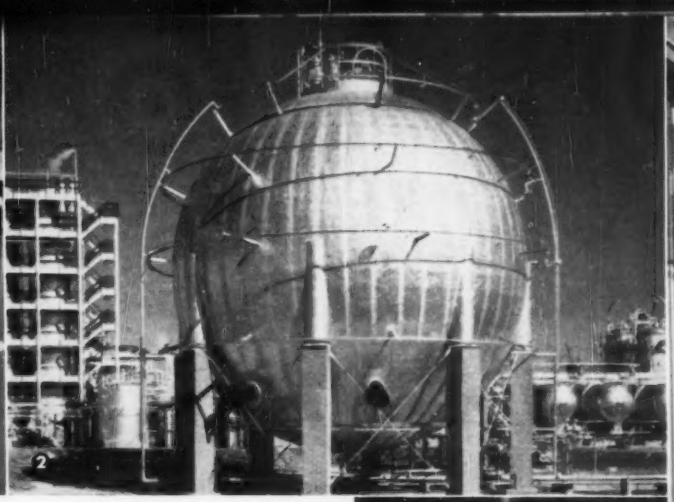
DIVISION OF acf INDUSTRIES
INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

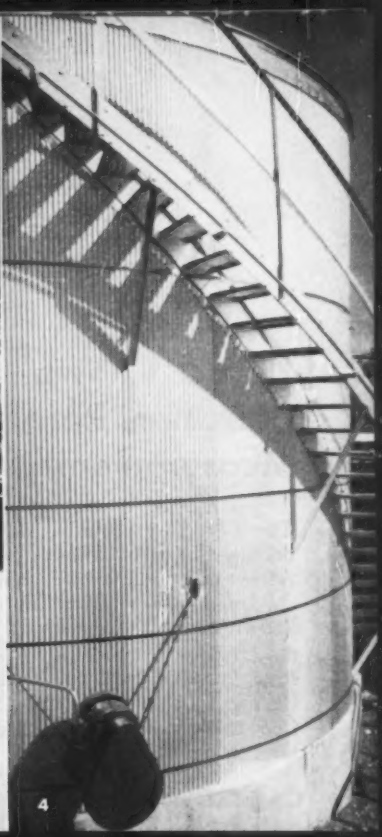
ACF non-lubricated Ball Valves feature full bore conduits, Teflon stem gaskets and seats that are sealed from the lading flow.

Working Pressures: In carbon steel with ASA ratings of 150 and 300, and a few sizes in ASA 600; in semi-steel with 200 and 400 pound ratings.

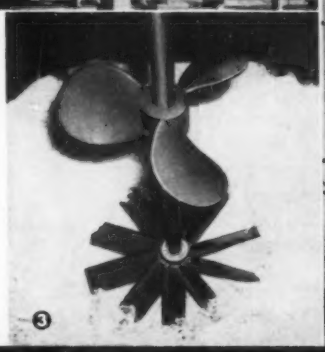
Sizes: ½" through 6".

5911-R2

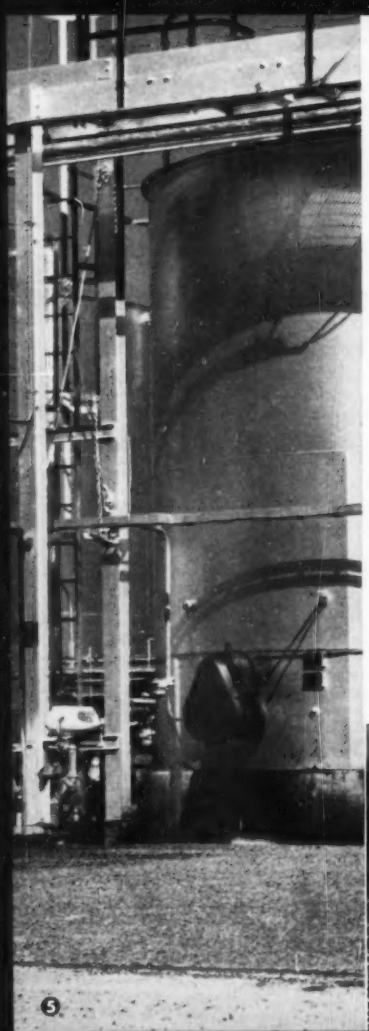




1. Ore purification in pressure vessel with Nettco tank top turbine mixer.
2. Butadiene blending with Nettco side drive mixers having replaceable, mechanical seals.
3. Violent agitation as produced by Nettco's unique combination of turbine and propeller drives.
4. Maintaining product uniformity in Styrene storage tanks with Nettco side drive mixers.
5. Blending with Nettco side drive mixer in storage tank containing 20% caustic solution.
6. Small batch blending with versatile Nettco portable mixer.
7. Standardization of finished product with rugged Nettco vertical turbine mixers.



Improved Processing through Engineered Agitation



WHAT'S THE BEST MIXER FOR YOUR PARTICULAR JOB?

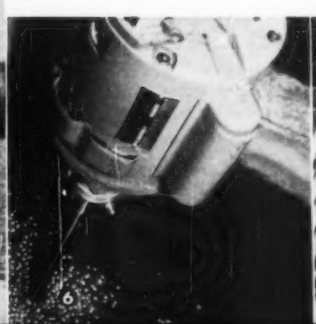
FLUID MIXING demands specialized, highly technical know-how. There is no single mixer which is "best" for every job. Only a mixing specialist can combine and coordinate agitation technology with mixer design and optimum horsepower to achieve an exacting result.

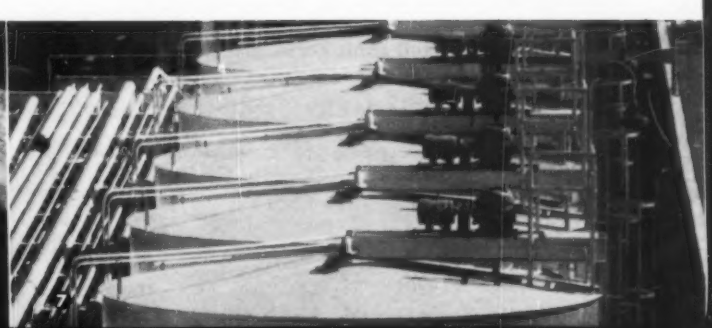
NETTCO ENGINEERED AGITATION provides a full evaluation of all application specifications, an analysis of performance data from pilot runs, and the careful selection of high quality, standard Nettco components to suit the specific job. *You* are assured of the result you want.

BACKED BY A FULL LINE . . . side drive, tank top, portable or tripod and continuous pipeline mixers . . . and thousands of performance-proven installations, like those illustrated, NETTCO can provide invaluable help in determining your fluid mixing needs. See *Chemical Engineering Catalog* or *Refinery Catalog* for our nearest representative, or write for Bulletin 581, NETTCO CORPORATION, 81 Tileston Street, Everett 49, Massachusetts.

NETTCO

ENGINEERED AGITATION SPECIALISTS





Instrument Monitors Corrosion Rates While Equipment Stays on Line

Fastest Known Corrosion Rate Measurement

The *Corrosometer* is its name. It proves the effectiveness of Nalco refinery stream corrosion inhibitors . . . in a hurry. It is the fastest known method of determining corrosion rates in operating equipment; manufactured by Crest Instrument Co. under license from Standard Oil Company (Indiana), and distributed worldwide, by Nalco.

Corrosometer readings are taken quickly and accurately, indoors or out. Instrument leads are attached to probes mounted in corrosion trouble spots. One instrument serves virtually any number of probes.

Coupons, Inspections are Slower

Determining corrosion rates by loss-in-weight methods, using coupons inserted in lines, is a much slower process. Valuable in determining average corrosion rates, it lacks the speed that enables the Corrosometer to reveal immediately any change in corrosion rate caused by process variations. Nalco Representatives, as well as Nalco Corrosion Inhibitor customers and prospects, welcome the speed with which the Corrosometer delivers accurate corrosion rate readings as a real contribution to time and money-saving establishment of good corrosion control practices.

Corrosometer Can Show Day-to-Day Corrosion Rates in System

Readings taken with the Corrosometer show the corrosion rate in the system for a predetermined interval of time. The interval may be as long as desired—or as short as a day or less. Thus checks of Nalco treatment effectiveness, as well as prompt detection of unexpected increases in corrosivity, are practical and accurate with the Corrosometer.

How Corrosometer Works . . .

Utilizing the Kelvin electrical bridge circuit, the Corrosometer compares resistances of two similar probes: one protected from corrosion, the other directly in contact with the liquid or gas in the equipment under test. Corrosion of the unprotected probe increases its electrical resistance, and the difference between probe resistances is directly convertible to corrosion-rate readings of high accuracy.

Retractable probes, for easy replacement without shutting down the system, and probes for high temperature and high pressure systems make the Corrosometer a valuable tool in checking Nalco Results in all types of corrosion-prone equipment.

Your Nalco Representative can give you full details on both the Corrosometer and Nalco corrosion inhibitors. Call him today — or write for descriptive literature.

Refinery Corrosion Probe

Retractable probe can be installed through a gate valve; replaced quickly without taking equipment off line.

National Aluminate Corporation is now

NALCO CHEMICAL COMPANY

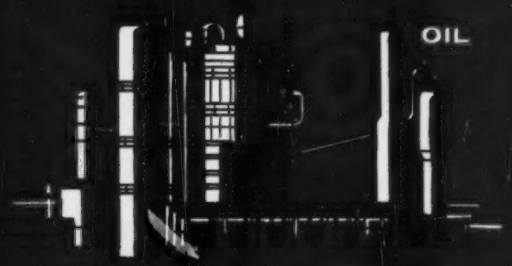
2650 West 66th Place • Chicago 38, Illinois

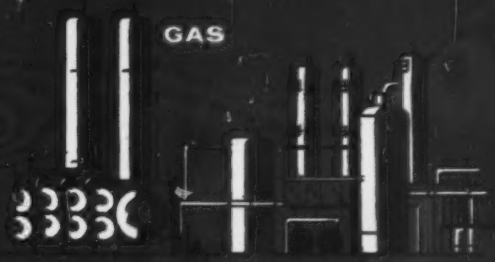
Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany

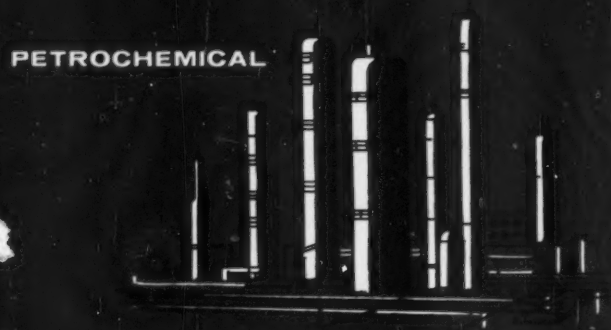
In Canada—Alchem Limited, Burlington, Ontario

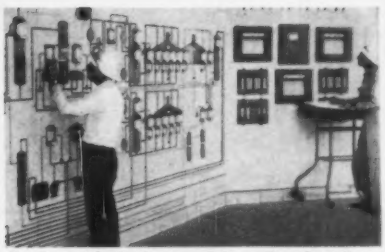
Nalco® ***Serving Industry through Practical Applied Science***

Nalco CHEMICALS



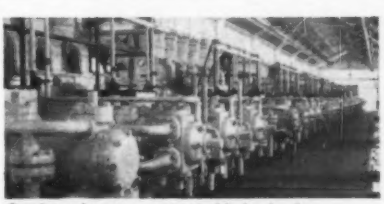




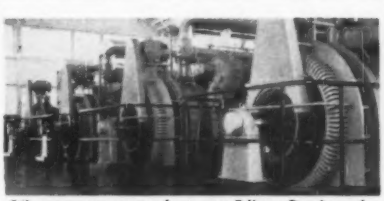


Omniguard indicating panel is easily adapted to miniaturized instrument panel installations for central control.

Detectors provide continuous temperature monitoring of drive motors for shipping pumps.



Omniguard system protects this bank of compressors installed at a natural gas cycling plant.



Oil company power plant uses Edison Omniguard system to protect generating equipment from overheating.

THOMAS A.

EDISON

omniguard system provides reliable, flexible temperature monitoring for oil, gas and petrochemical industries

Throughout your process, wherever temperature is critical, the Edison Omniguard system can protect vital equipment and output quality. It is the simplest and most flexible temperature monitoring system devised.

Plug-in detector units may be installed at key points throughout the process. They can be added or switched without disturbing the system. Typical detector locations include motor and motor bearings in shipping pumps, compressors and generating stations. Individual alarm settings on each point can be changed at any time without special tools.

Indicating panel can be located in central control room, for complete overall process monitoring by a single individual. Alarm system positively identifies trouble point.

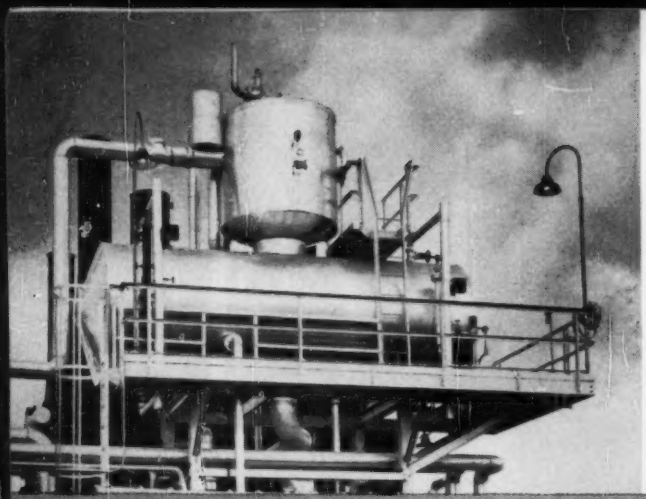
The complete system is designed for utmost reliability. There are no moving parts, nothing to wear out.

Edison engineers will be happy to provide assistance in designing the most efficient system to meet your requirements.

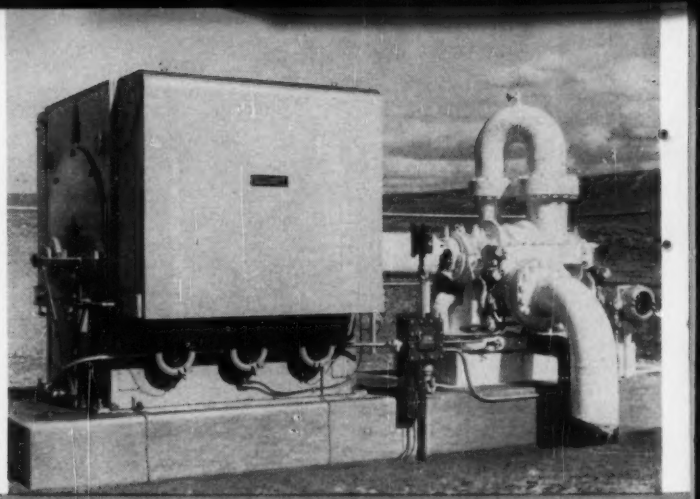
For additional information write for publication 3036-C.

Thomas A. Edison Industries
INSTRUMENT DIVISION
96 LAKESIDE AVENUE, WEST ORANGE, N. J.

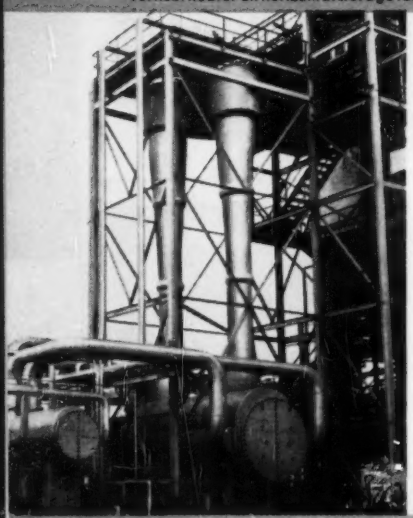
McGRAW EDISON



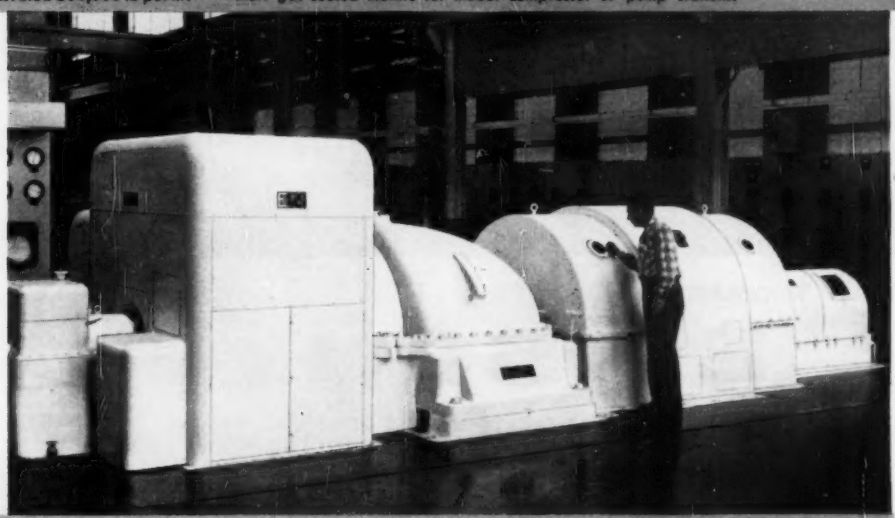
DEAERATING FEEDWATER HEATERS—precisely engineered by Elliott to requirements and space limitations—range in size to 2,500,000-lb-per-hr capacity. Elliott was first to advocate deaeration of water to prevent corrosion. Above refinery installation—a vertical heater on horizontal storage tank—is rated 200,000 lb per hr.



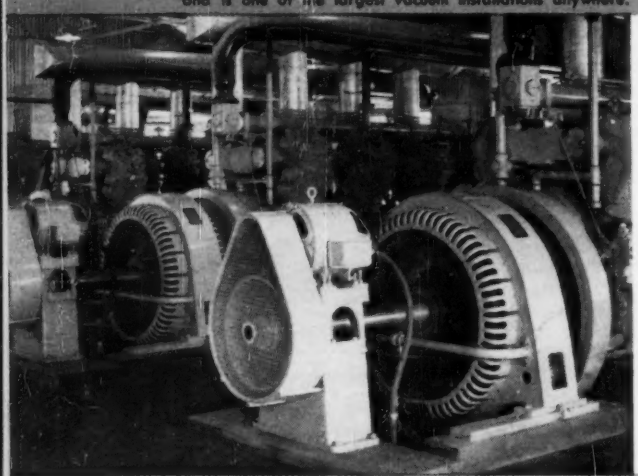
PUMPING STATION MOTORS—"tailored" by Elliott to outdoor pipeline service, eliminate costly housing. Above, Elliott 1500-hp, 2-pole "weather-protected" squirrel-cage motor direct-connected to two-stage oil pump. Elliott also builds externally-ventilated and inert gas-cooled motors for indoor compressor or pump stations.



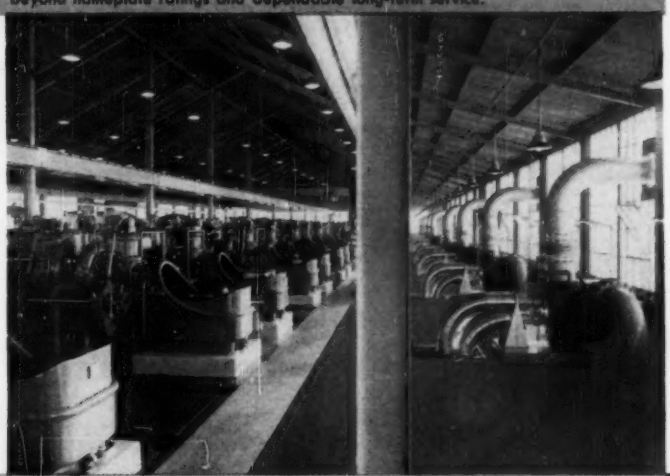
EJECTORS—designed and built by Elliott—range from size of man's hand to size of three-story building, such as the above twin three-stage ejector, with intercondensers, which serves one of the world's largest crude oil installations and is one of the largest vacuum installations anywhere.



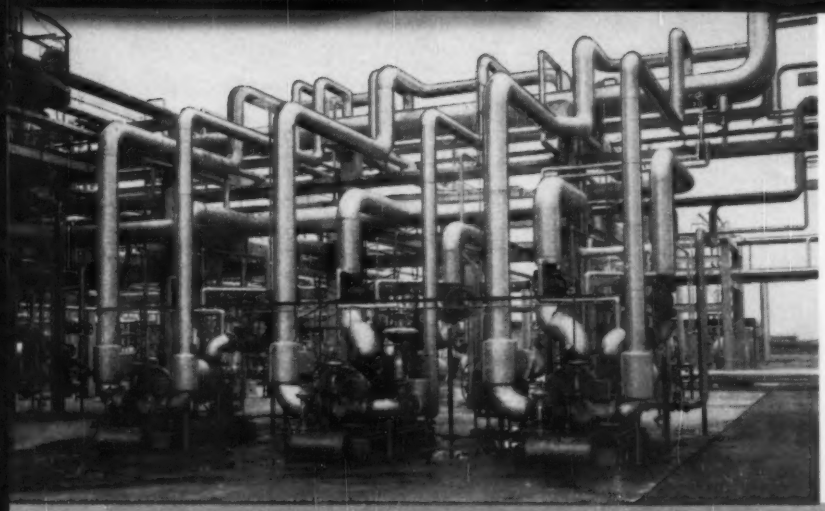
TURBINE-GENERATORS—this is one of three Elliott 4000-kw machines in one refinery power plant. They are served by Elliott surface condensers. Elliott builds turbine-generator units in size ratings up to 44,000 kw, which are noted for capability beyond nameplate ratings and dependable long-term service.



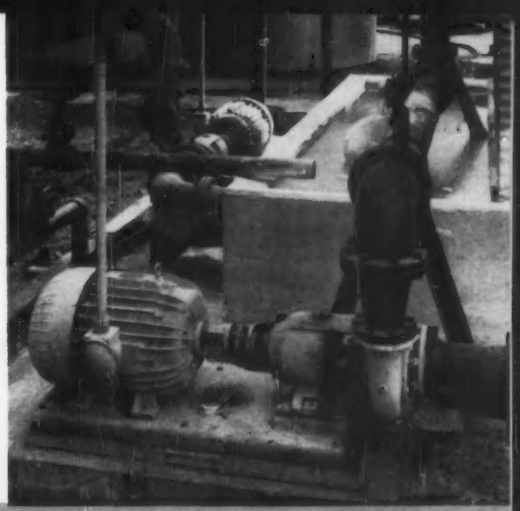
DIESEL-ENGINE GENERATORS—built by Elliott—are the product of 60 years experience. Here are three Elliott 280-kw, 400-rpm, gas-engine-driven generators serving a natural gasoline plant. They feature neat appearance, structural rigidity, long-lasting insulation and easy accessibility for routine cleaning and maintenance.



TURBOCHARGERS, above, right, are some of the 72 Elliott machines which helped increase pipeline pumping capacity 40% by supercharging old horizontal gas engines in nine compressor stations. No other manufacturer has so much experience in building turbochargers—covering the whole field of turbocharged engines.



TURBINES, single- and multi-stage, range from 5 to 20,000 hp. A typical line of Elliott single-stage turbines driving oil pumps is shown above. Simple design and rugged construction, plus excellent service records, have made these turbines favorites in refineries and gasoline processing plants.



MOTORS, totally-enclosed, fan-cooled, here drive pumps handling condenser water from cooling towers. Elliott introduced the "ribbed-frame" enclosed motor back in 1941. The explosion-proof version of this Elliott C-W motor is particularly well adapted for use in the petroleum industry.

throughout the petroleum industry

ELLIOTT EQUIPMENT IS ON THE JOB

An Elliott CONDENSER, (with EJECTOR and MOTOR and [illegible] pump drives) . . . and **CENTRIFUGAL COMPRESSORS** serve this refinery. Elliott has long experience in designing and building steam and electrical equipment to meet rugged, long-term 'round-the-clock service requirements of the petroleum industry.

Q9-2

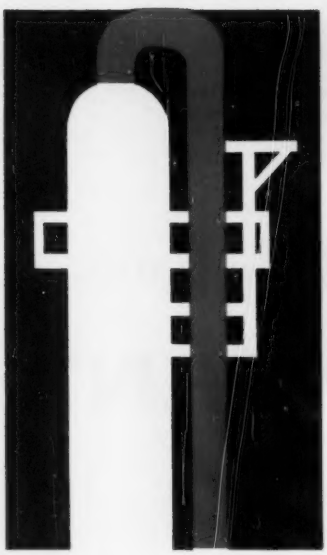
ELLIOTT Company

JEANNETTE, PENNSYLVANIA

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

IBM 1620 *data processing system*

...the most powerful engineering computer in its low price class



In the Petroleum Industry the IBM 1620 solves problems like these:

- *evaluation of refinery blending options*
- *oil transmission and product inventory data for pipe line supervision*
- *geological interpretation of seismic data*
- *design calculations*

The new IBM 1620 is a desk-size engineering computer that offers you more computing ability per dollar than any system in its price class.

Transistorized throughout, the IBM 1620 has a 20,000-digit magnetic core memory with variable field length and immediate accessibility. Its input output notation, on paper tape and console typewriter, is in convenient decimal arithmetic. It can perform more than 100,000 calculations a minute and is easily adapted to your engineering problems.

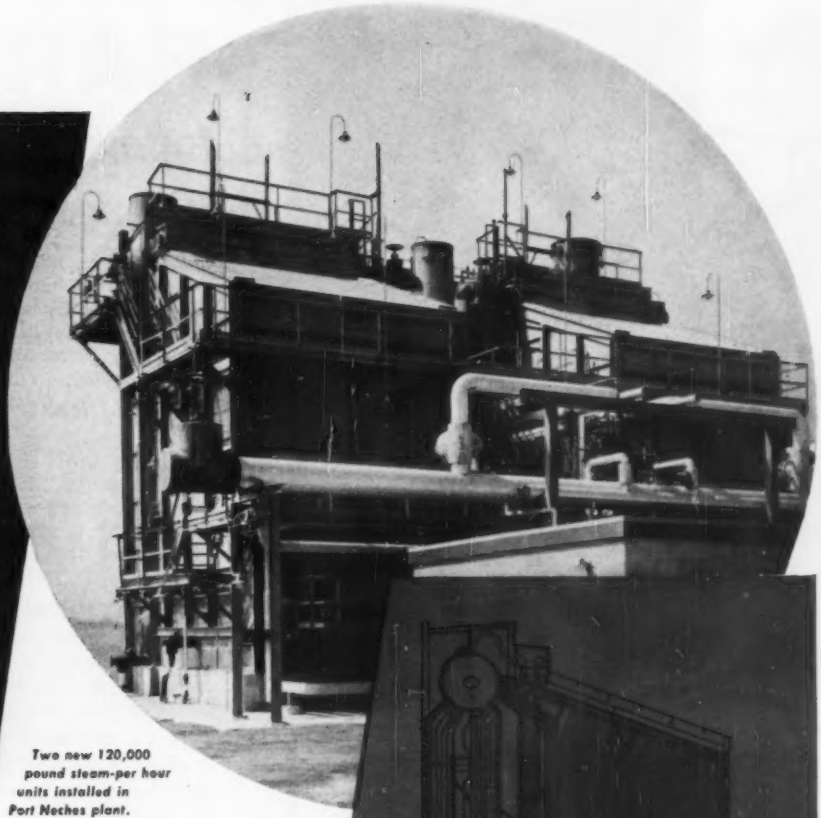
Easy to learn, easy to operate, easy to communicate with, the low-cost 1620 helps free your engineering talent for more creative work. And in keeping with our concept of Balanced Data Processing, the IBM 1620 is supported by extensive services. This includes a comprehensive library of mathematical routines and specific industry programs to permit you to put the 1620 to work without unnecessary delay.

Ask your IBM representative about the unique advantages of the IBM 1620. Like all IBM equipment, it may be purchased or leased.

IBM® *balanced data processing*

For more data on advertised products, use Readers' Service Cards, last page.

Steam for Jefferson Chemical by Vogt



Two new 120,000 pound steam-per hour units installed in Port Neches plant.

The needed additional power and process steam capacity for Jefferson Chemical's expanded Port Neches plant is furnished by the two Vogt boilers pictured here, each with a capacity of 120,000 pounds per hour. The boilers are designed for 675 lbs. pressure to operate at 625 lbs. pressure and 769°F. total temperature. The furnaces are equipped with gas burners and have water cooled front and side walls.

Bulletins describing Vogt boiler installations in a variety of industrial plants for power, processing and heating are available on request.

Installation by C. F. Braun and Co., Engineers.

For Custom Installation Bulletin VF-VS-2 • Package Unit Bulletin PSG-3, address Dept. 24A-BPR.

HENRY VOGT MACHINE CO., LOUISVILLE, KENTUCKY

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N.J., St. Louis, Charleston, W.Va., Cincinnati

Custom Built By..

STEAM GENERATORS

Vogt

For Maximum Resistance to HARBISON-

for every petroleum refining

H-W CASTABLE REFRACTORIES

They comprise all commercial classes. Proper brand selection provides the best combination of physical and chemical properties for specific applications—assuring maximum life and economy. Installation may be by various methods —gunning, trowelling, pouring or tamping—depending upon composition and application.

H-W CASTOLAST

This extremely high-purity, low-iron castable consists of accurately grain-sized tabular alumina and low-iron calcium-aluminate binder. It develops high strength throughout its temperature range, is unaffected by reducing atmospheres, and is very abrasion resistant. It is excellent for lining catalytic vessels, butadiene reactors, feed lines and cyclones.

H-W HARCHROME

This extra strength chrome-base castable with hydraulic binder takes an extremely hard, strong set. It is especially designed for maximum wear resistance in feed lines and cyclones of catalytic cracking units.

H-W EXTRA STRENGTH CASTABLE

A blended mixture of carefully sized hard-fired refractory aggregates, bonds and hydraulic binders, this product is strongest of all regular fireclay castables. It is highly recommended for regenerator and reactor linings, catalyst feed lines, cyclones, doors and sub-bottoms of various types of furnaces, and patching worn brickwork.

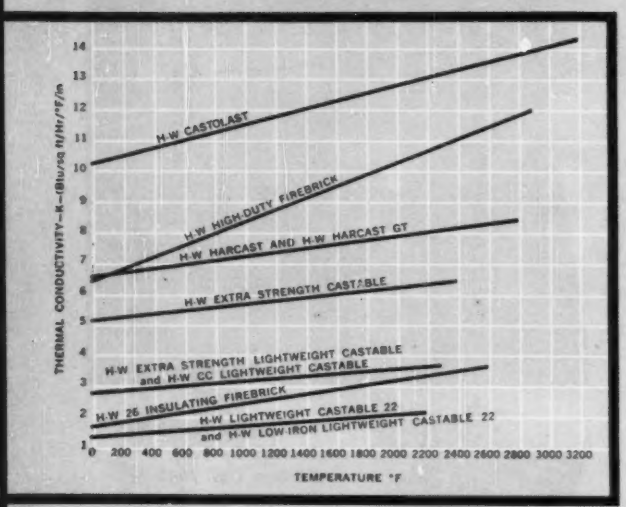
H-W HARCAST AND H-W HARCAST GT

These castables are manufactured from super-duty calcined fireclay carefully combined with high-purity plasticizers and hydraulic binders. The iron content in each is less than 1%, which adequately meets the specifications of petroleum companies. They are used where platinum catalysts are employed and provide exceptional strength at all temperatures up to their service limits.

H-W LIGHTWEIGHT CASTABLE 22

(Former brand name—H-W 56 Lightweight Castable)

A quality-controlled mixture of lightweight aggregates and hydraulic binders, it combines light weight and strength to utmost degree, has very low thermal conductivity and serves as an ideal insulation behind hard surface abrasion-resistant castables or brick. It gives outstanding service in regenerators and reactor linings, ducts and breechings, boiler wall backing and tube decks, air preheater linings, heater walls, roofs and door linings.



This Useful Chart—indicating service limits and comparative thermal conductivities (along with a table of physical properties)—is included in a newly-published brochure, "Harbison-Walker Refractories for the Petroleum Refining and Petrochemical Industries."

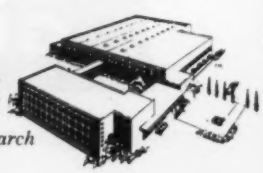
HARBISON-WALKER REFRACTORIES COMPANY

AND SUBSIDIARIES

GENERAL OFFICES: PITTSBURGH 22, PA.

World's Most Complete Refractories Service

Leadership in refractories through constant research



The Garber Research Center

Corrosion, Abrasion, Reducing Atmospheres . . .

WALKER REFRACTORIES

and petrochemical application

H-W LOW-IRON LIGHTWEIGHT CASTABLE 22

(Former brand name—H-W 56 Low-Iron Lightweight Castable)

Manufactured from low-iron lightweight aggregates and high purity calcium-aluminate binders, it is especially designed for oil refinery units operating in hydrogen and other reducing atmospheres.

H-W EXTRA STRENGTH LIGHTWEIGHT CASTABLE

(Former brand name—H-W 85 Lightweight Castable)

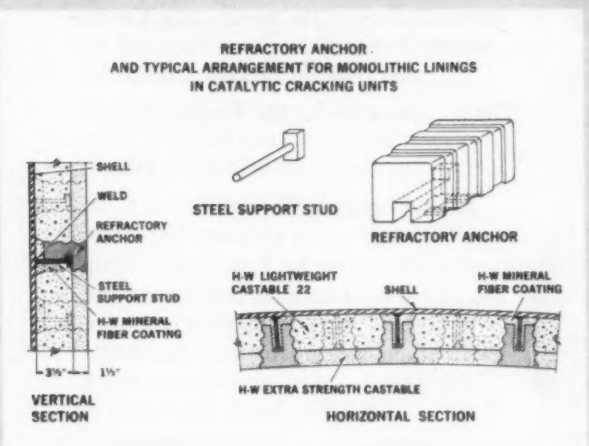
Consisting of carefully selected and sized lightweight aggregates and hydraulic setting binders, it has combined properties of light weight, high strength, low heat conductivity and desirable refractoriness. It is used for lining ducts and breechings, boiler wall backing and tube decks, furnace walls, roofs and doors.

H-W CC LIGHTWEIGHT CASTABLE

This combination of best selected and sized lightweight aggregates and hydraulic setting binders was especially developed for "one-shot" linings in catalytic cracking units.

IMPROVED ANCHORING METHOD

Supplementary to the conventional anchoring methods, the design of the refractory anchor installation shown here is particularly suitable for certain specific uses such as regenerators and reactor linings.



H-W REFRACTORY BRICK AND SHAPES

All classes of fireclay brick, high-alumina brick, silica brick, basic brick and acid-proof brick and tile are available for petroleum and petrochemical needs.

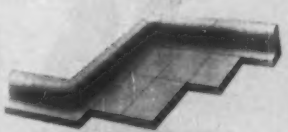
A Typical Duro Tower Packing Ring
Ring No. 403 6" x 6"

ALAMO AND VARNON

These brands possess chemical and physical properties which make them especially suited for the diversified operating conditions of refinery and petrochemical processes. Enhanced by high temperature heat treatment, VARNON has a high degree of immunity to damaging effects of carbon monoxide and hydrocarbon gases at critical temperatures.

H-W MULLITE—KORUNDAL—H-W CORUNDUM

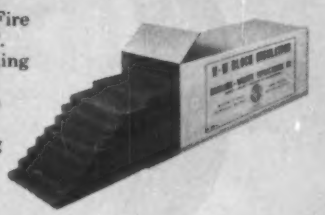
These high-alumina refractories are noted for unusual stability under severe temperature conditions, and excellent resistance to fluxing by corrosive slags and fumes, such as volatile alkalies and vanadium oxide present in the ash of some oils.



Duro Acid-proof Floor Tile

H-W INSULATING REFRACTORIES

All Classes of Insulating Fire Brick—1600°F. to 3000°F.
Mortars for Laying Insulating Brick
H-W Lightweight Castables
H-W Block Insulation
H-W Mineral Fiber Coating
H-W Finishing Cement



New Brochure

describes complete line of refractories for petroleum refining and petrochemical applications including all classes of castables, brick and shapes, insulating firebrick, block insulation, mineral fiber coating, finishing cement, and bonding mortars.

Send today for your personal copy

Harbison-Walker Refractories Company
Farmers Bank Building, Pittsburgh 22, Pennsylvania

☐ Please send me a copy of your new brochure, *Harbison-Walker Refractories for the Petroleum Refining and Petrochemical Industries.*

NAME_____

COMPANY_____

TITLE_____

ADDRESS_____

Heliflow® goes to sea with Triton

Heliflow heat exchanger designed for 2500 lbs. operating pressure on both shell and tube sides. All stainless 304 material

—and proudly so! In the instance of the Triton, Heliflow was selected by one of the most outstanding engineering organizations in the world—the **Knolls Atomic Power Laboratory** operated by the **General Electric Company.**

The requirements for the Triton job were most exacting—and Heliflow came through with flying colors.

Heliflow goes to sea with Triton to do another of the many vital and important jobs it has done for Uncle Sam during the past several decades both in war and peace. Whenever a really compact, efficient and dependable heat exchanger is required—to accurately do a tough job—Heliflow is the choice of capable engineers.

If Heliflow can do THIS job, don't you agree that it can do yours?

Ask for Bulletin 58E. It tells you why.

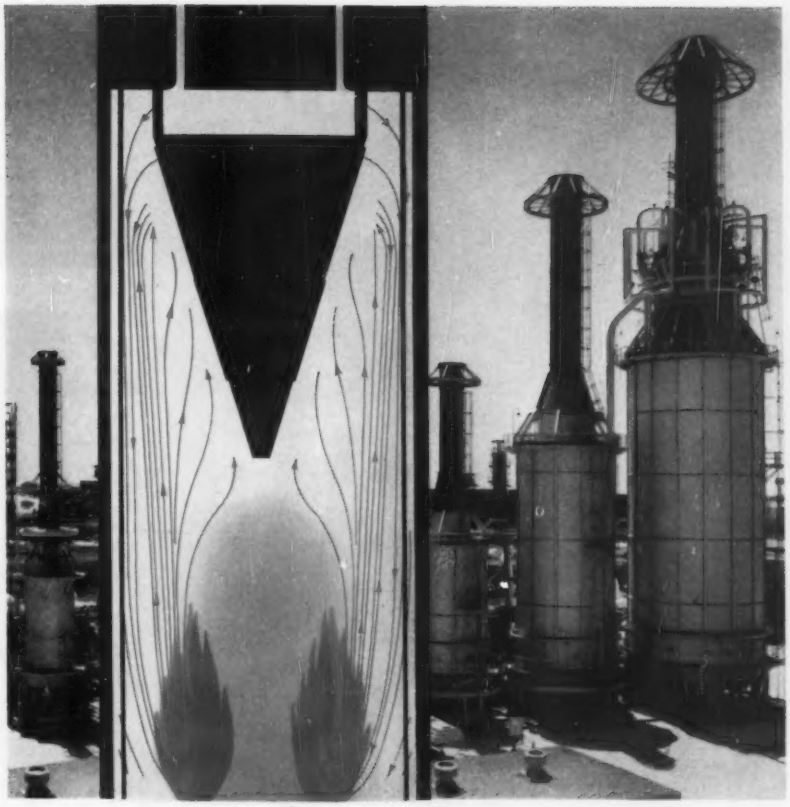
GRAHAM MANUFACTURING CO., INC.

Heliflow Corporation

170 GREAT NECK ROAD • GREAT NECK, NEW YORK

Offices in principal cities and Canada

Factory: Batavia, N.Y. Other Graham precision-built products: Steam Jet Ejectors, Monobolt Heat Exchangers, Deaerating Heaters, Surface and Barometric Condensers, Steam Vacuum Refrigeration, Aquamizer Evaporative Condensers.



PUTTING THE HEAT ON EVENLY EFFICIENTLY

Petrochem Isoflow Furnaces give even heat distribution—with added convection sections for maximum fuel efficiency

This is the heart of Petrochem Isoflow Furnaces—the furnaces that get more heat from every measure of fuel. Only Petrochem incorporates all three critical design features so important to highest efficiency in fired heaters: 1) burners specifically designed to furnace needs, 2) properly engineered firebox proportions, and 3) reradiation cones. These factors add up to a more even heat distribution and maximum heat efficiency. Even greater heat efficiency for certain heater applications can be obtained with Petrochem's added convection sections.

Cleaning is easier than with ordinary horizontal-type heaters. Only 25 per cent of the space normally needed is required to pull the tubes of a Petrochem furnace. When specifying furnaces—remember, *there are more Petrochem Isoflow Furnaces in service today than any other make.*

YUBA

specialists in process furnaces for every size, capacity and duty

PETROCHEM DEVELOPMENT CO.
122 East 42nd St., New York, N. Y. • A Division of
YUBA CONSOLIDATED INDUSTRIES, INC.

REPRESENTATIVES: Faville-LeVally Corp., Chicago • Flagg, Brackett & Durgin, Inc., Boston • D. D. Foster Co., Pittsburgh • William H. Mason Co., Tulsa • Lester Oberholtz Assocs., Los Angeles • Rawson-Houlihan Co., Inc., Baton Rouge • Ritteimeyer & Co., Atlanta • H. W. Severance, Prospect, Ky. • Turbex Equipment Co., Narberth, Pa. • G. M. Wallace & Co., Denver, El Paso & Salt Lake City • Combustion & Power Equipment Ltd., Montreal & Toronto • International Licensees and Representatives: Birwelco Ltd., Birmingham, England Fujinagata Shipbuilding Ltd., Osaka, Japan • Heurty Italiana, S.P.A., Milan, Italy • Petrochem, G.M.B.H., Dusseldorf, Germany • SETEA S.A., Buenos Aires, Argentina Societe Anonyme Heurtey, Paris, France • Societe Anonyme Belge Heurtey, Liege, Belgium.

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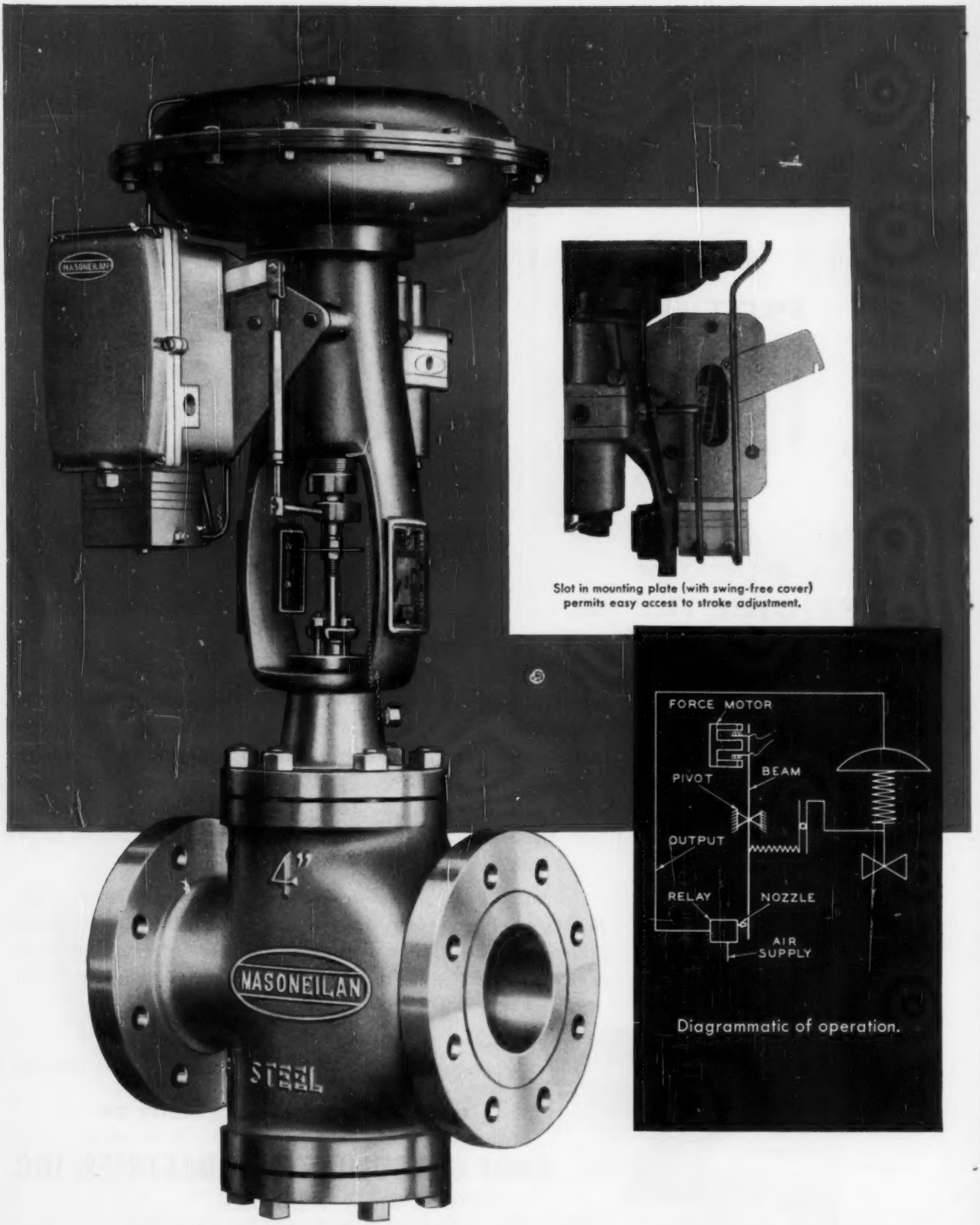
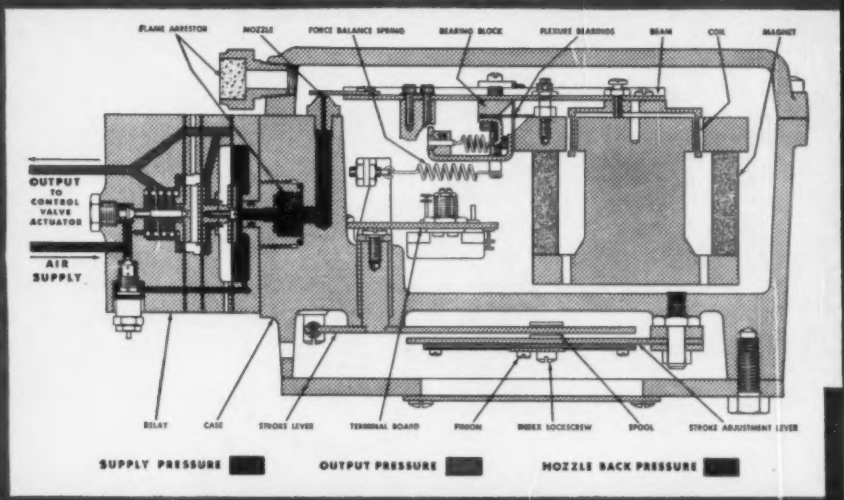


Model 8010 mounted on spring-diaphragm actuator. Note compact design.

Slot in mounting plate (with swing-free cover) permits easy access to stroke adjustment.

Diagrammatic of operation.

Schematic of air circuits.



Speed The speed of the positioner, with integral relay and normal 20 psi supply pressure, is tabulated below.

ACTUATOR SIZE	VALVE STROKE (inches)	SPEED (seconds)
9	½	1.5
	¾	1.8
11	¾	2.8
	1	3.3
13	1	4.9
	1½	6.3
15	1½	9.4
	2	11.4
18	2½	21
	3½	29
	4	32

Performance Data

Open-loop Gain* — approximately 100
Linearity — within ±1% of full stroke
Repeatability — within 0.2%
Load Sensitivity — Output pressure change of 1.2 psi per 0.1% of full stroke offset
Supply Pressure Effect — ±1% of full stroke for ±5 psi change from 20 psi

Now! Masoneilan E/P Positioner with Stem Velocity Feedback

Combines high open-loop gain and closed-loop stability to give you Precise Positioning and Superior Dynamic Response

The new Masoneilan Model 8010 Electropneumatic Positioner offers optimum performance plus these design advantages:

- A true positioner — *direct* comparison of valve stem position with controller output signal provides dynamic response and positioning accuracy not obtainable with transducer and pneumatic positioner combination.
- Electrical circuit easily adapted to a variety of controller output signals.
- Extra large stabilized magnet, plus efficient magnetic circuit, provides high force changes.
- Explosion-proof construction meets requirements of Class I, Division I, Group D.
- External stroke adjustment accessible without removal of cover — no exposure of electric wiring.
- High capacity relay for fast stroking speeds. Relay may be mounted in any one of four positions to facilitate piping.
- Balanced beam permits installation of valve in any position without shift in calibration.
- Available for 3-15 psi or 6-30 psi valve spring ranges and for split-ranging. Standard stroke ranges ⅜"–3" and 2"–4". Others available.
- Available with direct or reverse action and for direct or reverse actuators.

You can now utilize the desirable characteristics of electronic control and obtain the power and smooth throttling action of pneumatic valves by using Masoneilan Model 8010 E/P Positioners. Full details on request. Ask a Mason-Neilan representative or write direct —

MASONEILAN

MASON-NEILAN

Division of Worthington Corporation
51 NAHATAN STREET, NORWOOD, MASS., U. S. A.
Sales Offices or Distributors in Principal Cities in United States and Abroad
In Canada: Worthington (Canada) Ltd., Mason-Neilan Division

MND-41

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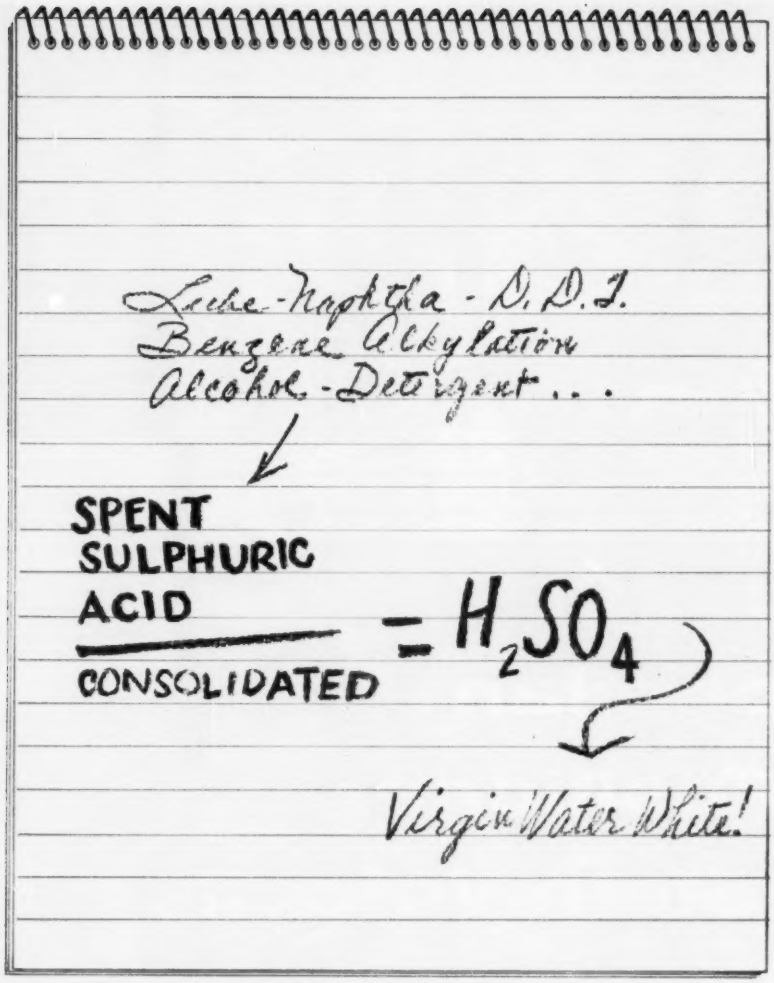

Send your spent sulphuric acid through Consolidated and get it back as water-white H_2SO_4. Normally we deliver 99% but you can have it to a fraction of a percent . . . tailor-made for your plant process as delivered.

Spent acid shipments and acid deliveries by truck, tank car or barge—yours or ours—to or from our regeneration plants at Houston and Baytown, Texas, Baton Rouge, La., Hammond, Ind., and Dominguez, Cal.

Consolidated transportation facilities are an advantage, too. We have a large fleet of barges and tank cars and an exceptionally fine traffic department. Movements are traced day by day...deliveries are prompt and reliable.

Sulphuric acid is also shipped from other plants at Fort Worth and Corpus Christi, Tex., LeMoyne, Ala., Vernon and Richmond, Cal., and Tacoma, Wash.

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, New York

Prudential Plaza, Chicago 1, Illinois — 636 California Street, San Francisco 8, California

824 Wilshire Boulevard, Los Angeles 17, California — P. O. Box 9716, Houston 15, Texas

CONSOLIDATED CHEMICAL INDUSTRIES DIVISION, 6910 Fannin St., Houston 25, Texas

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FALK and STEELFLEX are Registered Trademarks

Cut disconnect-reconnect time by as much as 50%

The FALK Spacer Coupling is specially designed for quick installation or removal *without disturbing the driving or driven unit.* This feature can save you up to 50% in disconnect-reconnect time when critical equipment—a process pump, for example—needs repair or replacement.

Here's another saving: with the FALK Spacer Coupling, you can quickly realign shafts *without the usual loss of operating temperature!*

And still another: you can remove or reinstall the FALK Spacer as a unit *without draining the lubricant.*

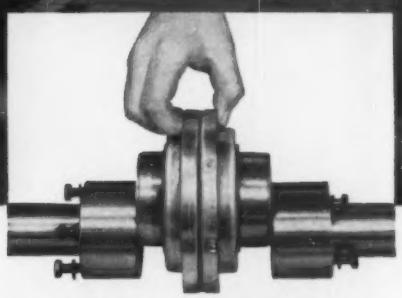
Because of its exclusive grid-groove Steelflex design, the FALK Spacer can accommodate residual misalignment—parallel, angular, or (most important) *both.* Also, it provides torsional resiliency that cushions shock and vibration. Thus it saves wear-and-tear on your connected equipment.

To prove these claims and enjoy these savings, install a FALK Spacer on one application—and see for yourself. Consult your FALK Representative or Authorized Distributor.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in many principal cities.

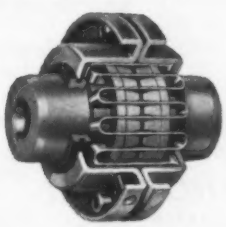


EASY AND QUICK TO INSTALL, DISCONNECT OR RECONNECT

First, mount shaft hubs to allow proper distance between hubs; then, align driving and driven units.

Second, compress Spacer to fit space between hubs and tighten cap screws to pull spacer hubs into the registered fit.

To disconnect, reverse the second step. No draining of lubricant necessary.



The heart of the FALK Spacer ...the basic Type F Steelflex

Write for Service Manual 4838

FALK

...a good name in industry

In industry, as in the home, there is always a job that calls for a specialist. One of the most critical is critical piping. You will save yourself headaches and much money if you assign your next job of prefabricating and installing high-pressure, high-temperature piping directly to specialists. Ask us in.

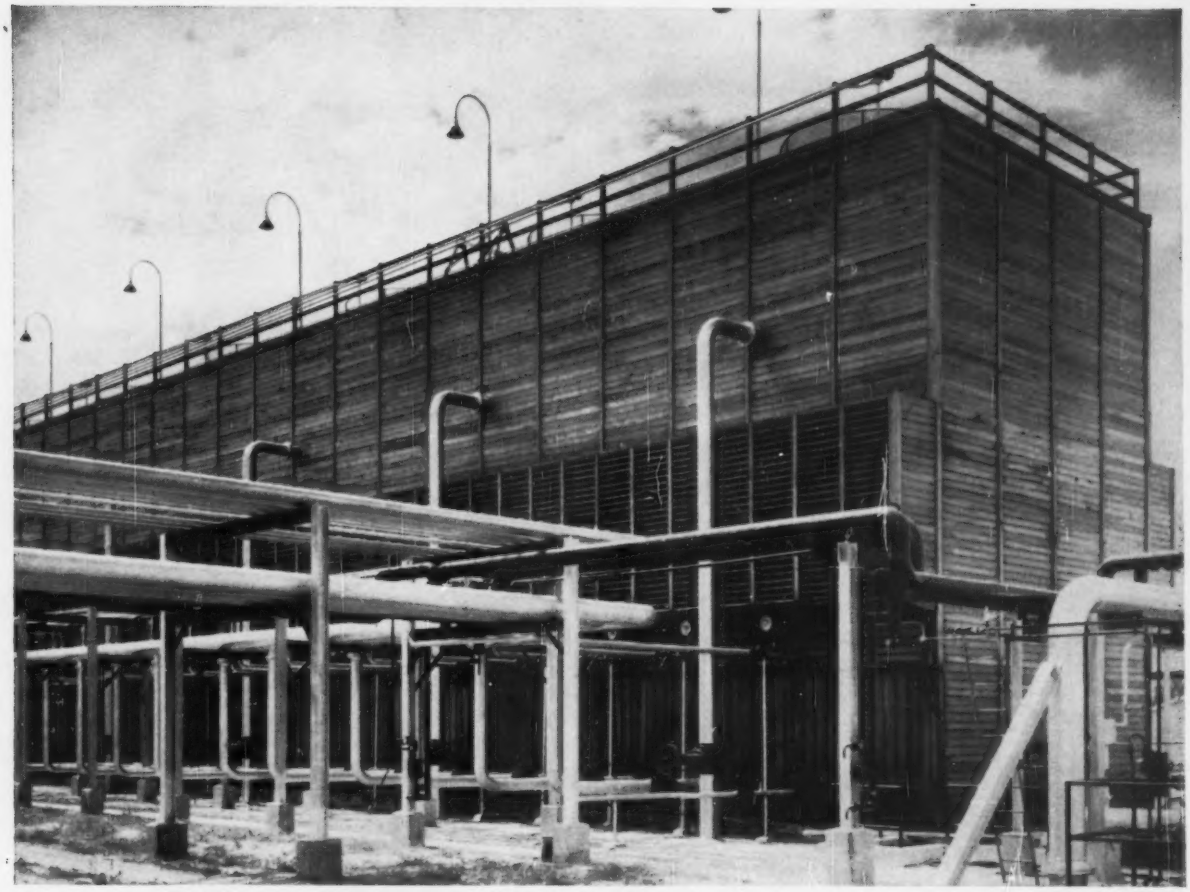
W. K. MITCHELL & CO., INC.

Philadelphia 46, Pa.

WESTPORT JOINT
(PATENTED)

MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS



CHROMATE COMPOUNDS STOP CORROSION *before it starts!*

Long before the first drop of water contacts metal in any large recirculating water system, steps should be taken to prevent corrosion.

Early in the design stage, plan on adding a chromate inhibiting compound to recirculating water—from the moment operation starts. That way, clean metal stays clean. Chromate inhibiting compounds will also arrest corrosion in older systems that have been operating without protection, even where rust and scale make it more difficult for inhibitors to reach and protect the metal.

Chromates work two ways: they make waters non-corrosive while making metal surfaces corrosion-resistant. Chromate inhibiting compounds are easy and inexpensive to use. Since conditions and equipment vary, a variety of compounds are available to meet individual requirements.

For the names of manufacturers of corrosion inhibiting compounds containing Mutual Chromium Chemicals, or information on Mutual Chromium Chemicals, mail the coupon below.

Mutual® Chromium Chemicals

Sodium Bichromate
Sodium Chromate
Chromic Acid
Potassium Bichromate
Potassium Chromate
Ammonium Bichromate
Koreon (one-bath chrome tan)

Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N. Y.

MUTUAL Chromium Chemicals are available through dealers and SOLVAY branch offices located in major centers from coast to coast.

MUTUAL CHROMIUM CHEMICALS
SOLVAY PROCESS DIVISION
Allied Chemical Corporation
61 Broadway, New York 6, N. Y.

Please send:

☐ List of manufacturers of corrosion inhibiting compounds.
☐ Booklet "Mutual Chromium Chemicals."

Name_____ Position_____

Company_____

Street_____

City_____ Zone____ State_____

23-10

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REFINERY REPORT: **CO 15**

This B&W CO® BOILER Converts Waste Heat To Profit For

SOHIO

It was purchased by The Standard Oil Company (Ohio) for their ultra-modern, completely-integrated refinery in Toledo, Ohio.

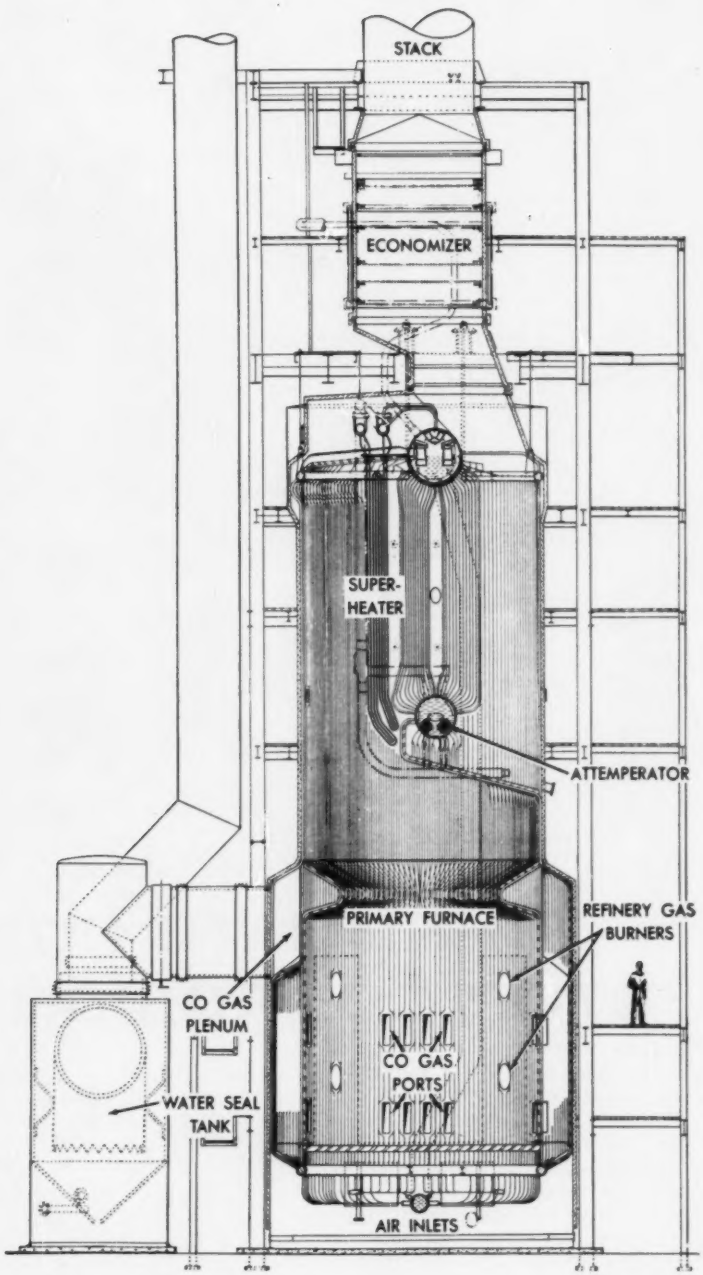
It is designed to use the heat in waste CO gases from the cracking unit to generate steam for the refinery's power and process needs.

It does just that. Hour after hour. Day after day. Week after week. Dependably and efficiently.

It will save enough fuel to pay for itself in less than 3 years.

Probably, a B&W CO Boiler can do the same for your refinery.

Find out. Write us today. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.



CO-104

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

gum formation can destroy a gasoline's good name... protect yours with Tenamene

Eastman gasoline additives

When buying gasoline additives, keep these three points in mind:

One, Eastman offers you every principal type of gum inhibitor in commercial use today.

Two, Eastman, as a basic manufacturer of the additives it supplies, maintains complete control every step of the way, assuring you of a uniform product and consistent additive performance.

Three, Eastman petroleum specialists provide on-the-spot service to make sure you obtain the most efficient use of the additives you buy. Ask them about cutting costs through bulk delivery.

You'll find Eastman petroleum specialists can give you unequalled technical service because inhibition of gum formation is their only interest. EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tenn.; Atlanta; Chicago; Cincinnati; Cleveland; Detroit; Framingham, Massachusetts; Greensboro, N. C.; Houston; New York City; St. Louis. **West Coast: Wilson Meyer Co.,** San Francisco; Denver; Los Angeles; Phoenix; Salt Lake City; Seattle.

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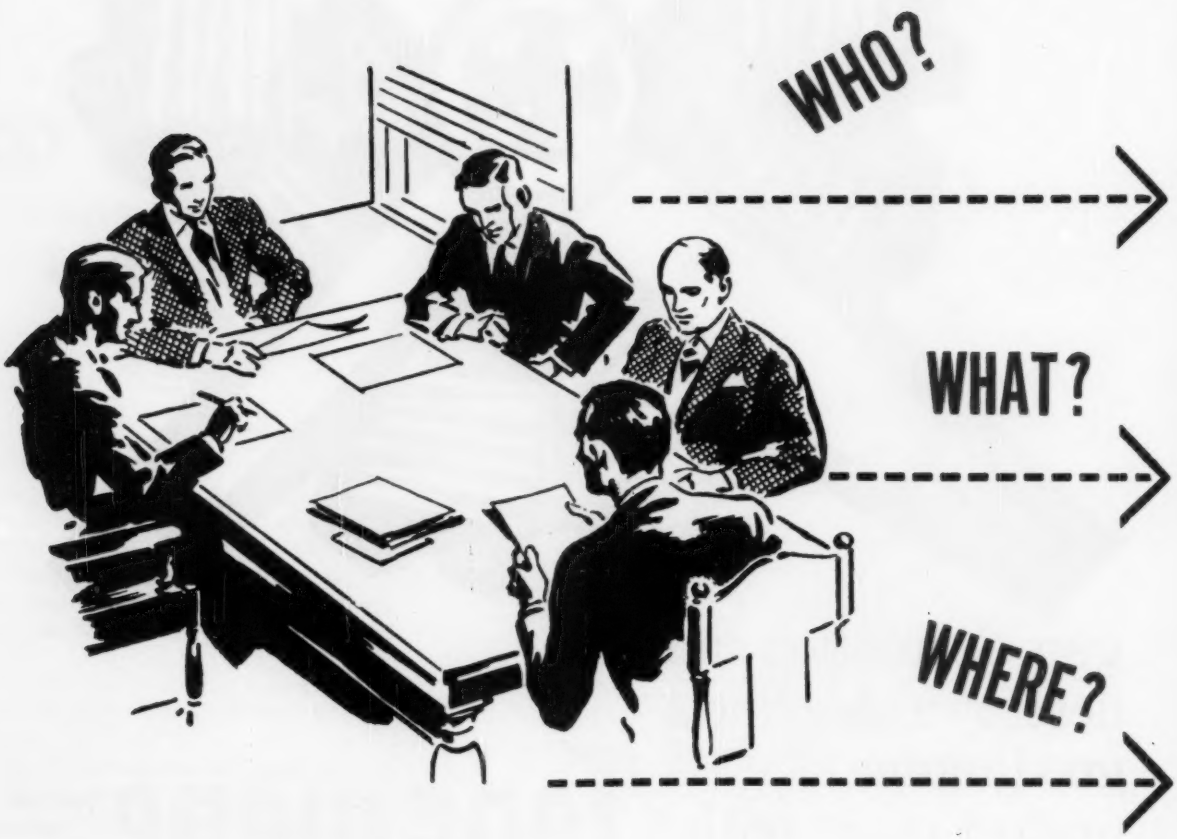
With Men

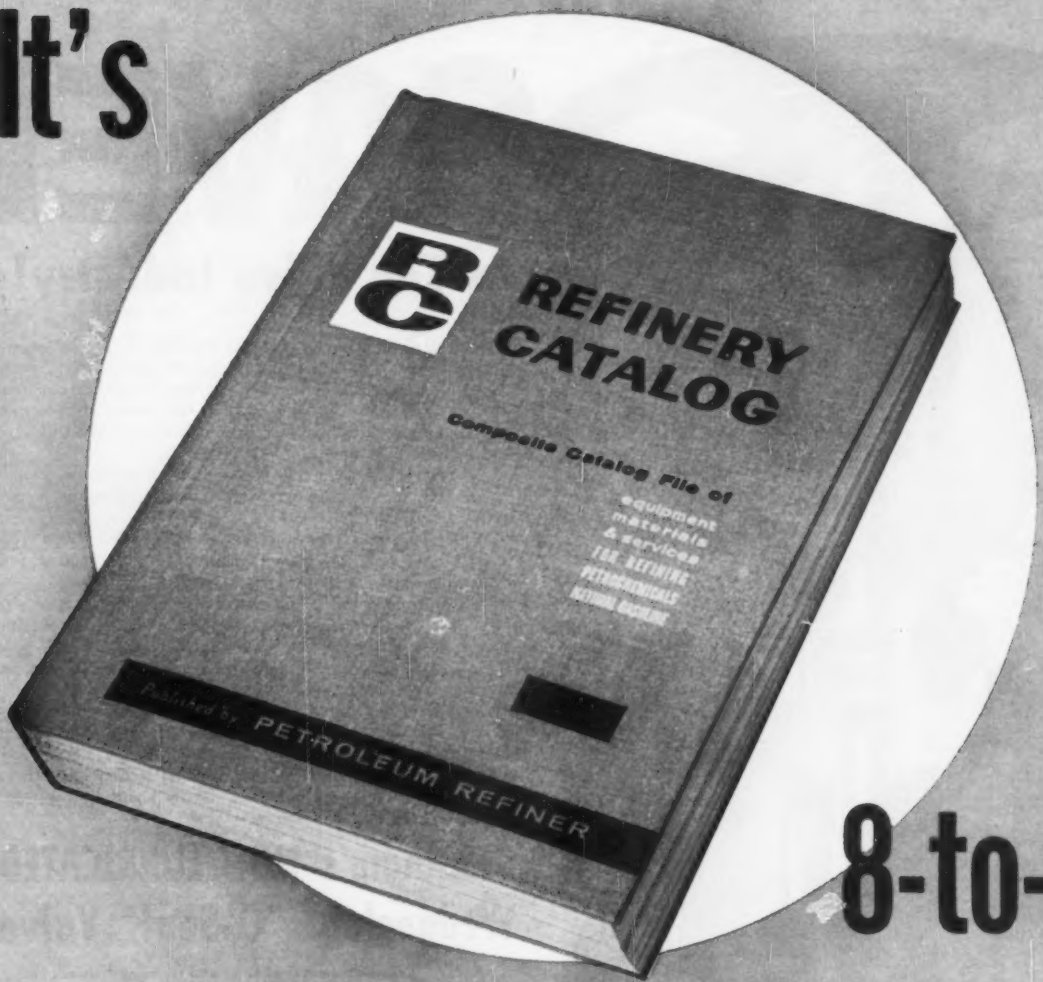


REFINERY CATALOG

Published by Petroleum Refiner

Who Buy And Specify

It's



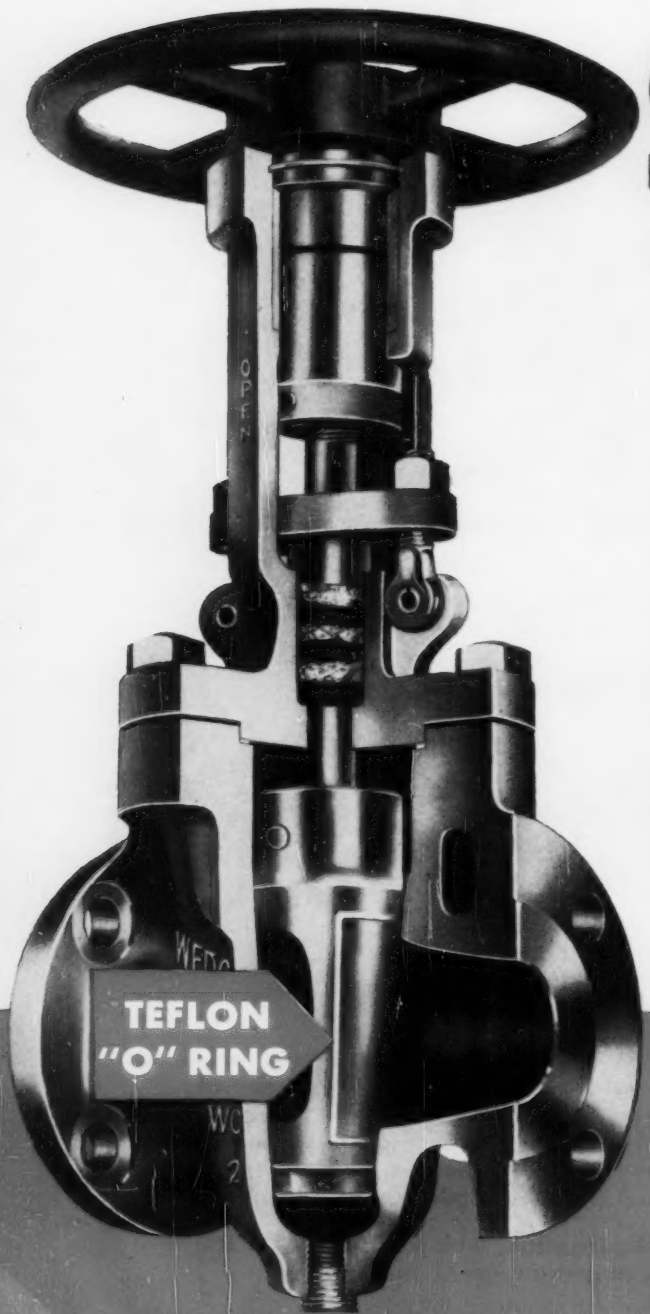
8-to-1

Look to REFINERY CATALOG for quick answers to your procurement problems in the refining, natural gasoline and petrochemical industry. It's indexed and cross-referenced to save time and eliminate error in planning, buying and specifying for this fast-moving market. That's why buyers and specifiers express a preference of 8-to-1 for REFINERY CATALOG over individual product catalogs.

The next time *you* sit down to figure a job, look *first* in REFINERY CATALOG. You'll find it contributes to greater speed and accuracy.

BIGGEST MONEY SAVER

In The Valve Industry!



You're familiar with the expense involved in the lubrication of plug valves — the high monthly cost of man hours, grease and equipment, or of a lubrication service. The contaminating influence of the lubricant is also a constant hazard. Not to mention the sticking and leakage that occur when lubrication of a particular valve is overlooked.

These are some of the reasons why Stockham's Wedgeplug "O-Seal" Valve is rapidly replacing lubricated valves in general purpose services everywhere.

The other reason is, simply, that the non-lubricated "O-Seal" equals or betters the performance of any lubricated valve — without costing a cent for maintenance.

Two Teflon† "O" rings in the plug provide absolute shut-off — shut-off that remains permanently "bubble-tight" on both the upstream and downstream seats. Thus, the "O-Seal" provides double-block and bleed in most services. The "O-Seal" has proven itself absolutely leakproof on hundreds of services.

Flawless machining of metal seats provides shut-off in case of fire — double seating for double *safety*. And the "O-Seal" is *guaranteed not to stick*.

Call your Stockham Distributor or Sales Representative now, or write Stockham for complete details about how you'll save money — from now on — with

Stockham's NON-LUBRICATED Wedgeplug* "O-Seal" Valve

Complete ranges of sizes and types available.

†Teflon, Dupont Trademark *Patented

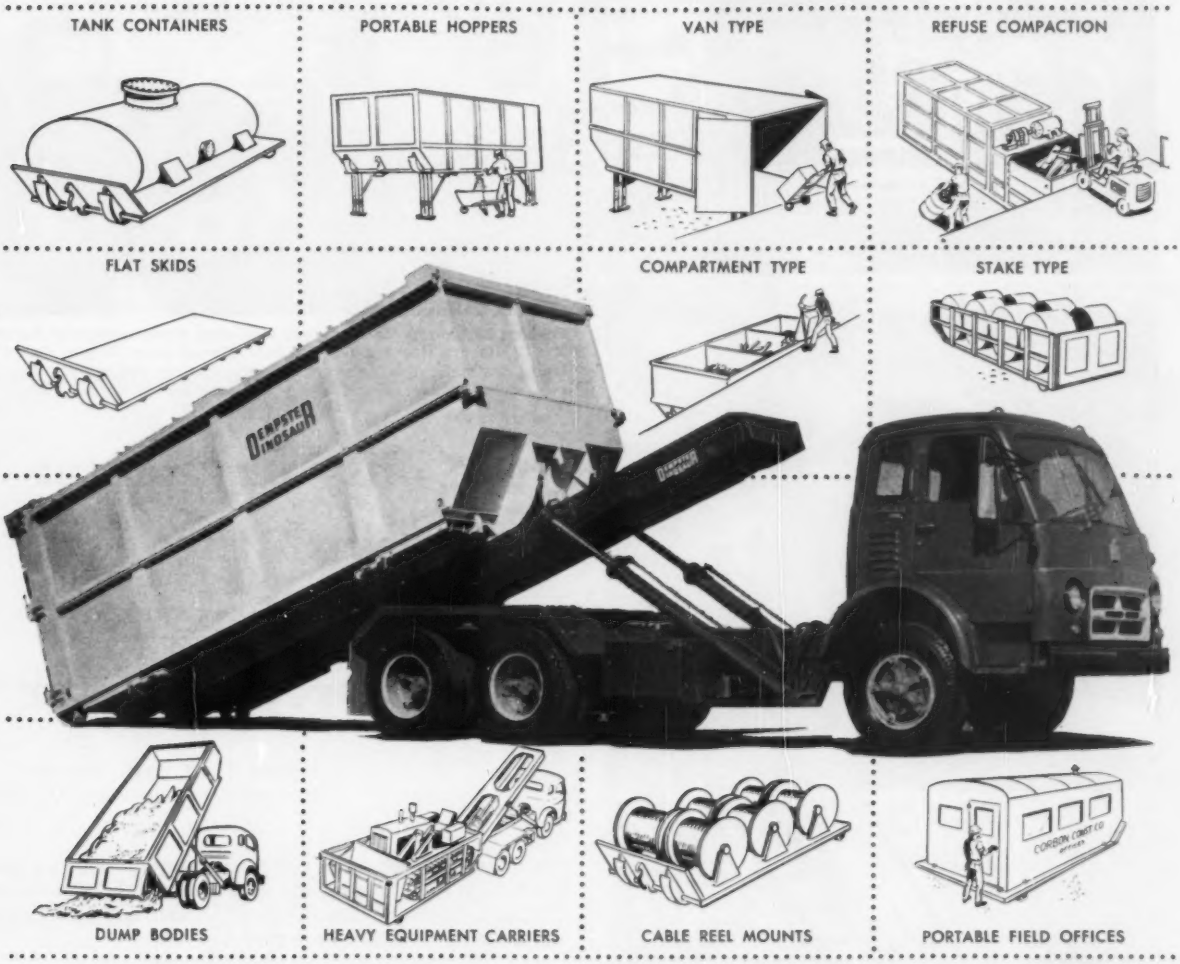
WEDGEPLUG VALVE COMPANY
DIVISION OF

STOCKHAM
VALVES *and* FITTINGS

General Offices and Plant
4000 North 10th Avenue Birmingham 2, Alabama

CAST IRON-MALLEABLE AND DUCTILE IRON PIPE FITTINGS — BRONZE, CAST IRON, DUCTILE IRON, CAST AND FORGED STEEL VALVES
Sold Only Through Distributors

One DINOSAUR With Detachable Containers Solves Many Complex Materials Handling Problems



Patents Pending

Here's tne materials handling tool that takes up where the fork-lift truck leaves off. Gigantic loads can be placed on skids, in tanks or containers. The DEMPSTER-DINOSAUR picks them up . . . automatically . . . in seconds . . . and whisks them to their destination, in-plant or to over-the-road locations. Here they are put down, intact . . . pushed off on a dock . . . left on telescopic legs . . . or dumped.

One truck handles any number of containers of many types. Value of truck is multiplied . . . standing-idle time is eliminated . . . loading and handling is cut to the minimum. One man, the driver, handles the all-hydraulic operations without leaving the cab.

Containers available up to 40 cu. yds. and over . . . loads are limited only by the capacity of the truck. If you have a special problem send it in.

Write for FREE BROCHURE

DEMPSTER BROTHERS
Inc.
Knoxville 17, Tennessee, Dept. PR-1

To: DEMPSTER BROTHERS, Dept. PR-1
Knoxville 17, Tennessee

Please send free Dinosaur Brochure

Name _____ Title _____

Firm _____

Address _____

City _____ State _____

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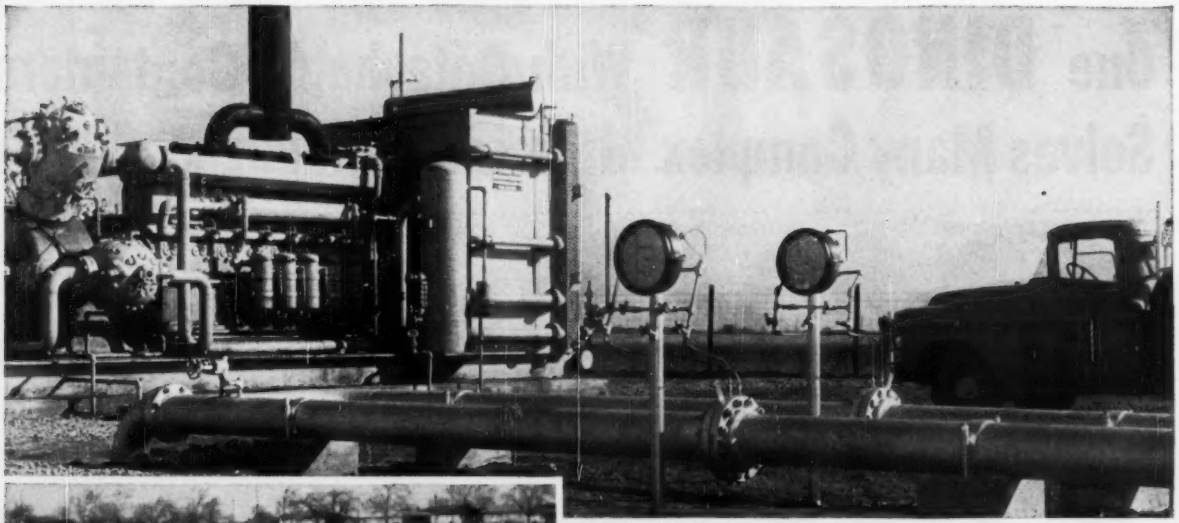

Foxboro Diaphragm Meters on gas well head measurements at Sunray Mid-Continent's Moore, Oklahoma field. Meters return to zero instantly when flow stops — have no ambient temperature effects, even though temperatures have ranged from −9°F to +105°F.

"the only dry meter with the solid pen-power of a mercury meter"

. . . reports H. H. (Pat) Everett
Sunray Mid-Continent Oil Co.

Fastest zero return of any dry meter on intermittent gas flows. That's just one reason why Sunray Mid-Continent Oil Co. finds the Foxboro Type 37 Diaphragm Meter perfect for gas wellhead flow measurements.

Sunray currently has 47 Diaphragm Meters in operation on gas separator and compressor stations in the Oklahoma City district, with 13 more due to be installed shortly.

District Superintendent H. H. (Pat) Everett also reports that his Diaphragm Meters have never needed calibration since they were installed. And they're completely free from zero drift and ambient temperature effects . . . resulting in the highest sustained accuracy of mercury-less gas flow measurement. No wonder Sunray says the Type 37 outperforms all other dry flow meters!

You'll find Foxboro Diaphragm Meters provide highly accurate, dependable records of all gas flow measurements. Get full details from your nearby Foxboro Field Engineer, or write for Bulletin 7-15A. **The Foxboro Company, 741 Norfolk St., Foxboro, Massachusetts.**

FOXBORO
REG. U.S. PAT. OFF.

FIRST IN FLOW

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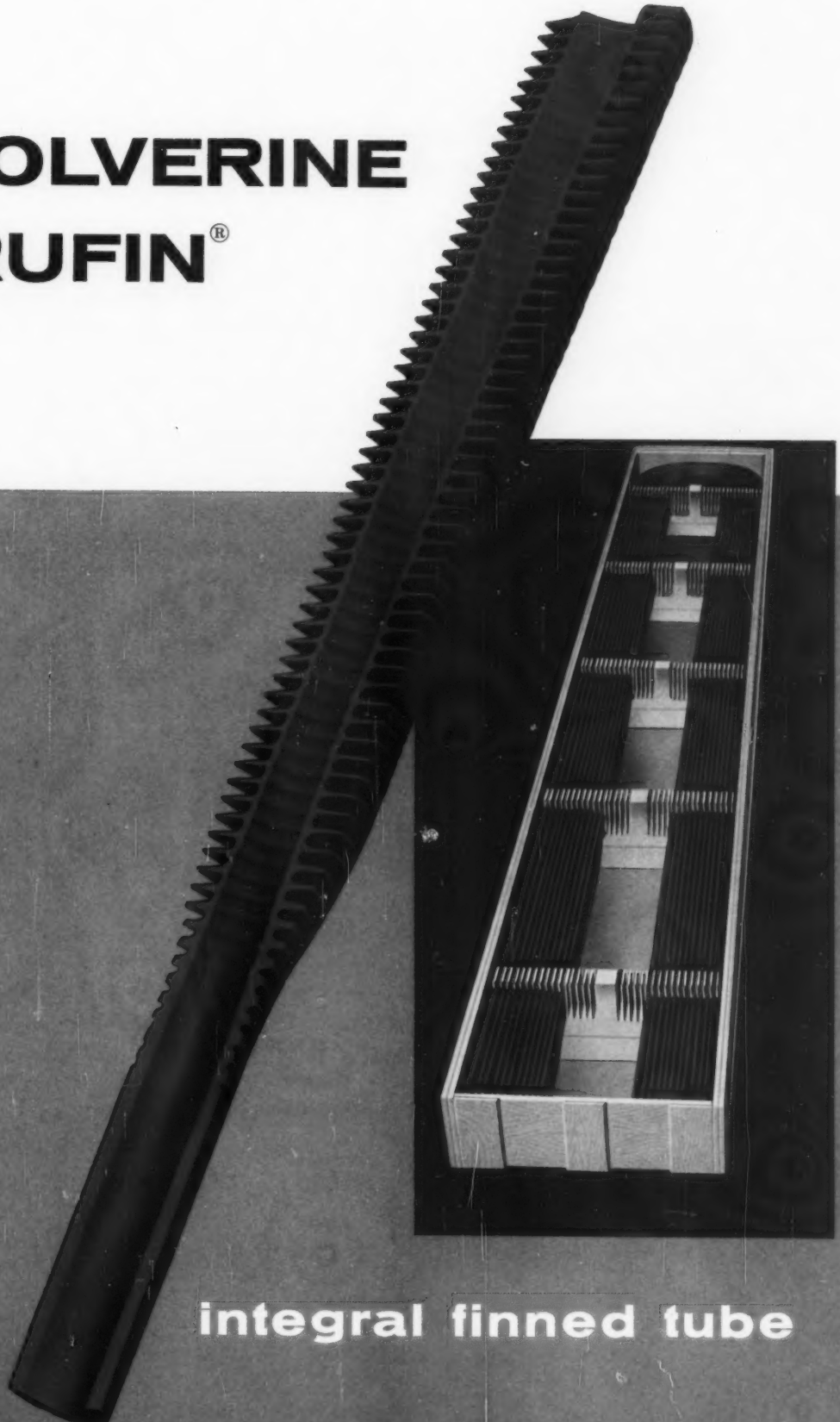
WOLVERINE TRUFIN®



the integral finned tube

interchangeable with plain condenser tube (Type S/T only)
easily fabricated— available in U-bends
one-piece construction
several types of end treatments available
high finned outside to inside surface ratios up to 8-1. (Types H/R, L/C, and I/L)
available with either high or low fins with a wide variety of fin spacings

smooth extruded fins eliminate sharp angles and crevices

fins stand up under thermal shock, vibration and pressure changes

available in copper, copper alloys and aluminum

more BTU's per foot of tube

THIS IS WOLVERINE TRUFIN!

Look at the advantages—see for yourself what Trufin can do for you. Specify it for new installations and for retubing at turn-around time. You'll do a bigger job . . . boost production . . . save money, too!

THE THINGS YOU MUST KNOW ABOUT FINNED TUBE

EXPERIENCE

Where finned tube and heat transfer experience is concerned, Wolverine Tube is the industry's acknowledged leader. Wolverine pioneered the development of integrally finned tube (Wolverine Trufin®) and over the years has produced millions upon millions of feet of this efficient extended surface for countless heat transfer installations throughout the United States.

HEAT TRANSFER SPECIALISTS

In addition to a fully staffed Field Engineering Service, Wolverine Tube also maintains Technical Heat Transfer Specialists in all major processing areas across the country. These men have all undergone intensive training in finned tube technology and have completed a Process Heat Transfer Course conducted by Donald Q. Kern, Wolverine consultant.

RESEARCH AND DEVELOPMENT

Wolverine Tube maintains the industry's most complete research and development facilities in Allen Park, Michigan. Here, day-in and day-out, research delving into all aspects of tubing manufacturing is carried out. Extensive research in finned tube and heat transfer has been conducted at the University of Michigan for many years in Wolverine's behalf. You can rest assured, as a result of all of these activities, that Wolverine Tube contributes its full share to the advancement of tubing technology. You can be sure, too, that because of these facilities you can place your complete trust in any product bearing the Wolverine name.

Next time you require finned tube—or have a tubing problem—consult Wolverine Tube. Either way you'll be sure of the finest product or soundest advice available.

Wolverine Trufin is available in Canada through the Unifin Tube Division, London, Ontario.

CALUMET & HECLA, INC.
CALUMET DIVISION
URANIUM DIVISION
GOODMAN LUMBER DIVISION
WOLVERINE TUBE DIVISION

In Canada:
CALUMET & HECLA OF CANADA LIMITED
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO., LTD.
UNIFIN TUBE DIVISION

WOLVERINE TUBE
DIVISION OF
CALUMET & HECLA, INC.
17236 Southfield Road
Allen Park, Michigan
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

AMOCO CHEMICALS—A NEW RESOURCE

Five AMOCO Additive Product Bulletins to help you

Here are five informative bulletins that give technical data helpful in evaluating AMOCO Additives. Bulletins document with test data and comparative illustrations, the performance of motor oils and gasolines containing AMOCO Additives. Typical physical and chemical properties of the additives are included. Technical service by experienced petroleum additive engineers, to assist you in the use of AMOCO Additives, is also available.

AMOCO 193 INHIBITOR
Gives information on this multi-functional zinc dithiophosphate motor oil additive which inhibits oil oxidation, protects bearings from corrosion, and prevents excessive wear of critical engine parts.

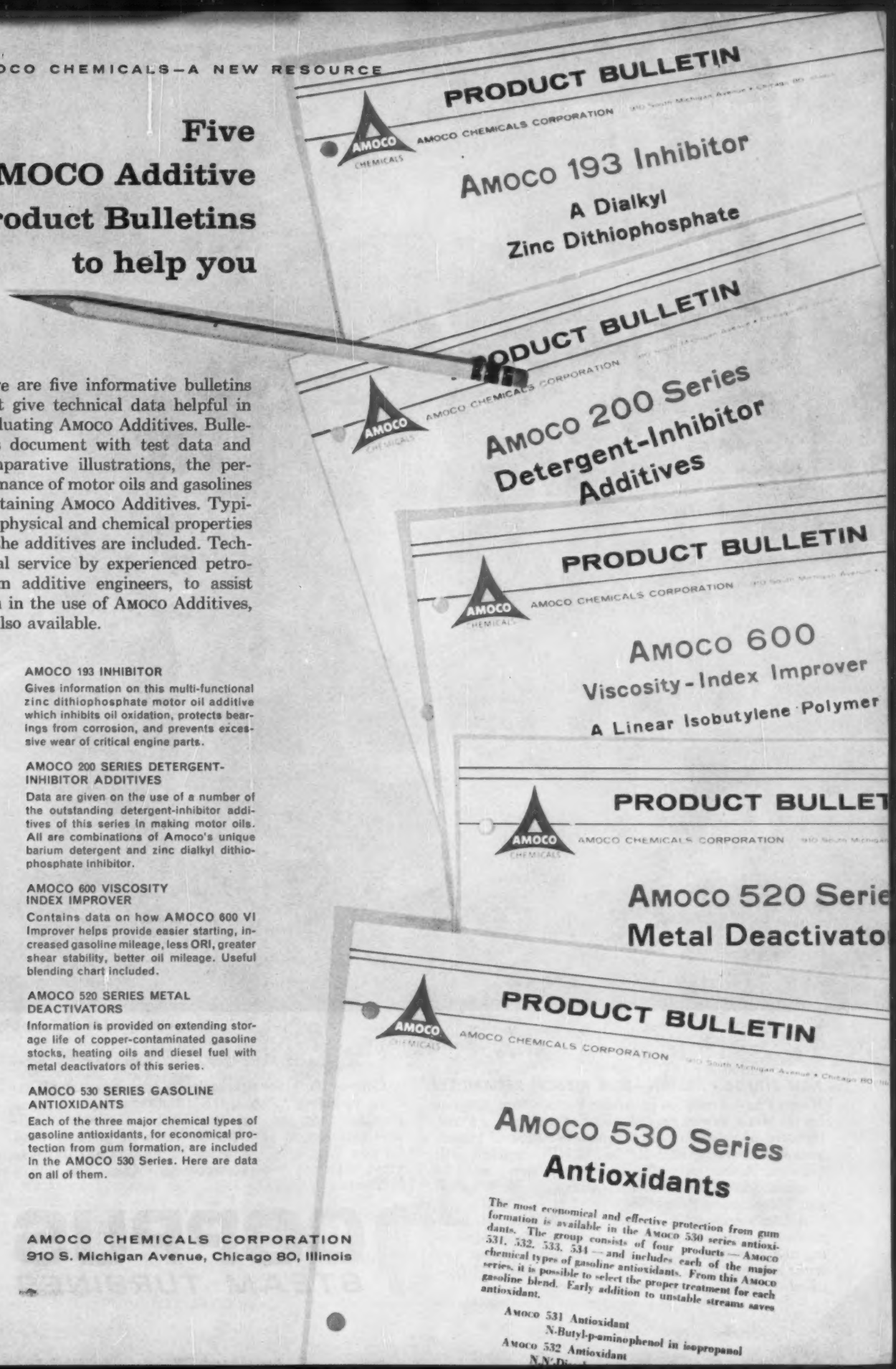
AMOCO 200 SERIES DETERGENT-INHIBITOR ADDITIVES
Data are given on the use of a number of the outstanding detergent-inhibitor additives of this series in making motor oils. All are combinations of Amoco's unique barium detergent and zinc dialkyl dithiophosphate inhibitor.

AMOCO 600 VISCOSITY INDEX IMPROVER
Contains data on how AMOCO 600 VI Improver helps provide easier starting, increased gasoline mileage, less ORI, greater shear stability, better oil mileage. Useful blending chart included.

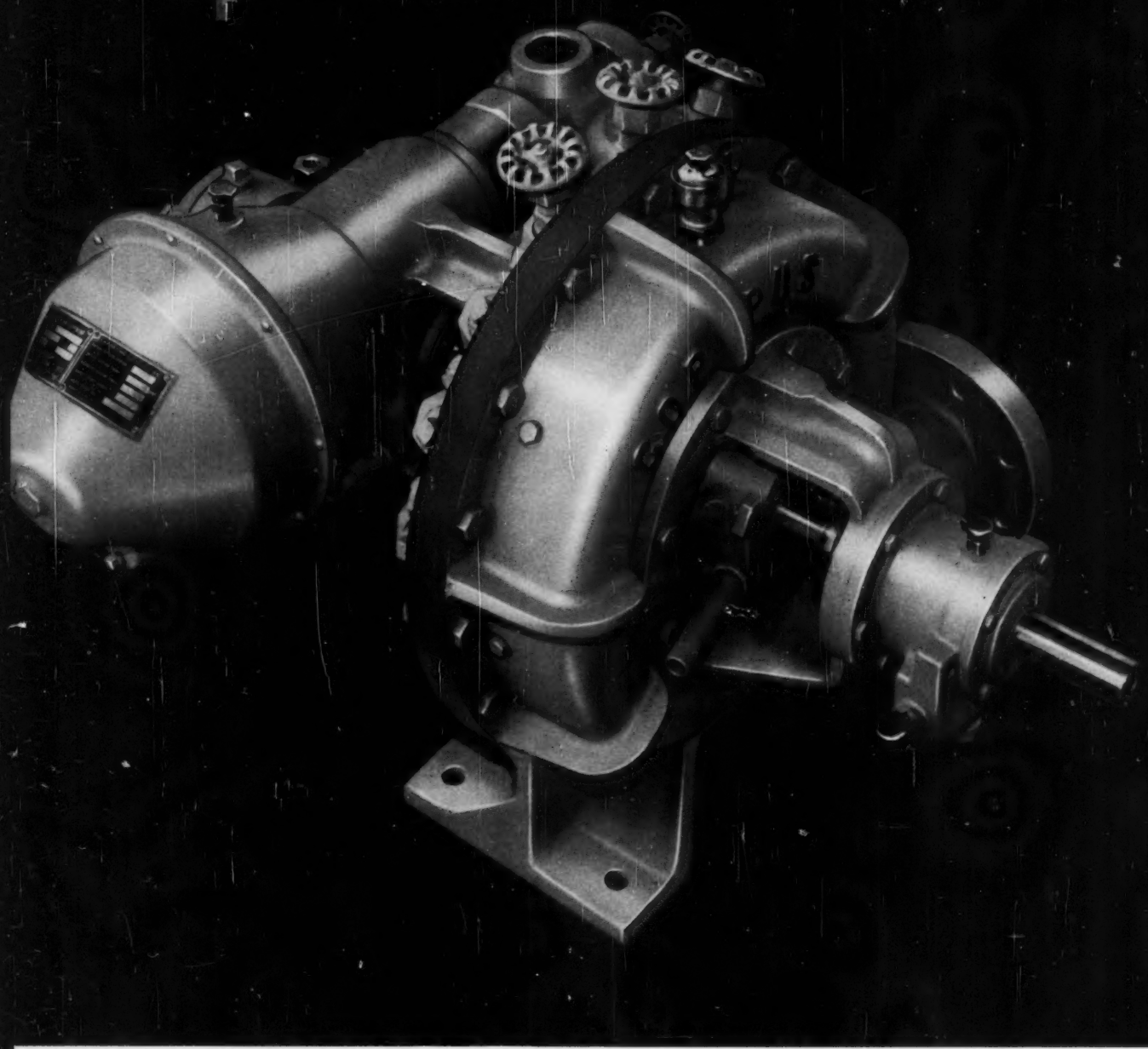
AMOCO 520 SERIES METAL DEACTIVATORS
Information is provided on extending storage life of copper-contaminated gasoline stocks, heating oils and diesel fuel with metal deactivators of this series.

AMOCO 530 SERIES GASOLINE ANTIOXIDANTS
Each of the three major chemical types of gasoline antioxidants, for economical protection from gum formation, are included in the AMOCO 530 Series. Here are data on all of them.

AMOCO CHEMICALS CORPORATION
910 S. Michigan Avenue, Chicago 80, Illinois


PRODUCT BULLETIN
AMOCO CHEMICALS CORPORATION
AMOCO 193 Inhibitor
A Dialkyl
Zinc Dithiophosphate
PRODUCT BULLETIN
AMOCO CHEMICALS CORPORATION
AMOCO 200 Series
Detergent-Inhibitor
Additives
PRODUCT BULLETIN
AMOCO CHEMICALS CORPORATION
AMOCO 600
Viscosity-Index Improver
A Linear Isobutylene Polymer
PRODUCT BULLET
AMOCO CHEMICALS CORPORATION
AMOCO 520 Serie
Metal Deactivato
PRODUCT BULLETIN
AMOCO CHEMICALS CORPORATION
AMOCO 530 Series
Antioxidants
The most economical and effective protection from gum formation is available in the AMOCO 530 series antioxidants. The group consists of four products — AMOCO 531, 532, 533, 534 — and includes each of the major chemical types of gasoline antioxidants. From this AMOCO series, it is possible to select the proper treatment for each gasoline blend. Early addition to unstable streams saves antioxidant.
AMOCO 531 Antioxidant
N-Butyl-p-aminophenol in isopropanol
AMOCO 532 Antioxidant

COPPUS BLUE RIBBON PRODUCTS



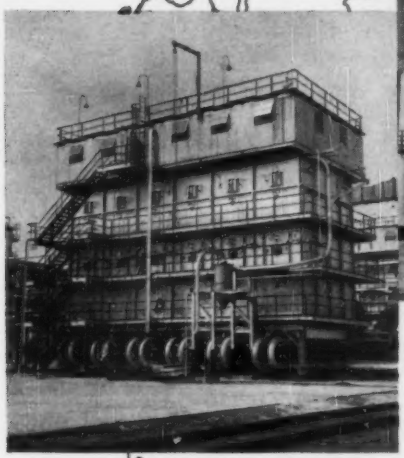
Coppus Horizontal Steam Turbine

NEW RUGGED DESIGN—BLUE RIBBON RELIABILITY!
Here's a new dimension in turbine performance! Coppus brings you a new rugged stability of design . . . a new measure of reliability in a complete range of power-packed turbines, from 1 HP to 250 HP — marked with the Blue Ribbon only after each is precision made . . . precision tested. Performance features like these assure you Blue Ribbon Reliability —

A totally enclosed governor . . . totally enclosed, independently operated safety trip . . . easily replaceable packing and bearings . . . multiple steam nozzle control . . . brake rim for added safety . . . wide bucket "L" type wheel (optional) for minimum water rate.

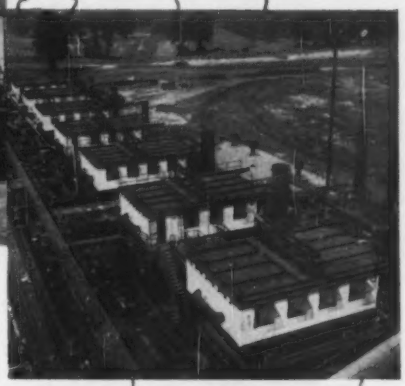
Coppus Turbines are built to customers' specifications, including API and NEMA standards. All Coppus Products carry the same Blue Ribbon assurance of reliable performance. For further facts on turbines, send for new Catalog 200. COPPUS ENGINEERING CORPORATION, 411 Park Avenue, Worcester, Mass. Sales Offices in *Thomas' Register*.

COPPUS
STEAM TURBINES



One of two 15 million cubic feet per day Girdler hydrogen reformers at a Delaware refinery.

Girdler hydrogen plant, a part of catalytic reformer installation in Gilsonite, Colorado.



Three large hydrogen plants have been built at widely separated locations for the Nitrogen Division of Allied Chemical Corporation.

HYDROGEN

In the last decade, most of the hydrogen plants installed in the United States and Canada have been built by Girdler.

This performance alone provides undisputed evidence of Girdler's ability and know-how and assures you of dependable design, engineering and construction. You can count on Girdler to help you when you're considering a new plant, or enlarging your present facilities for producing hydrogen or synthesis gases for ammonia, methanol, oxo-process, etc.

GIRDLER CONSTRUCTION CORPORATION
P. O. Box 174
LOUISVILLE 1, KENTUCKY

For complete information, write or wire today for this free 36 page book all about hydrogen and its production.

GIRDLER

chemical processes and process plants

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YOUR *FISHER/MAN* STANDS BEHIND THIS

FOR Inherent Accuracy–Power–Speed–and Stability

FISHER TYPE 470 P.O.P.

- Delivers same power in either direction at any point of the stroke.
- No air set required—utilizes clean, noncorrosive air or gas up to 150 psi.
- Adaptable to virtually all types of valve bodies including Butterfly valves.
- Easily reversible actuator can be changed in the field.

This small, compact, pneumatically operated piston is available in five sizes with yoke sizes to fit any of the Fisher valve bodies including Butterfly valves. P.O.P. acts with high speed. For example, the 8½-inch size gives you 1.5 inches per second stroking speed. Write Fisher Governor for Bulletin E-59.

Type 470 P.O.P. With Fisher Bodies

Cylinder Size, Inches	Yoke Boss Size, Inches	Valve Body Size, Inches	Stem Size, Inches	Allowable Stem Force, Lbs.
4¾	2⅛	½—1½	⅜	1,500
	2 13/16	2—4	½	*
	3 9/16	5—8	¾	*
6⅛	2 13/16	2—4	½	2,500
	3 9/16	5—8	¾	*
8½	3 9/16	5—8	¾	5,000
10¾	5	10—16	1	8,000
13	5	10—16	1¼	12,000

*Limitation with these stems is dependent upon the maximum force available from each cylinder.

See chart in figure 3.

Available with large variety of accessories such as: spring return, side mounted handjack, hydraulic snubber and pneumatic safety return devices. Write for Bulletin E-470.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

FISHER GOVERNOR COMPANY

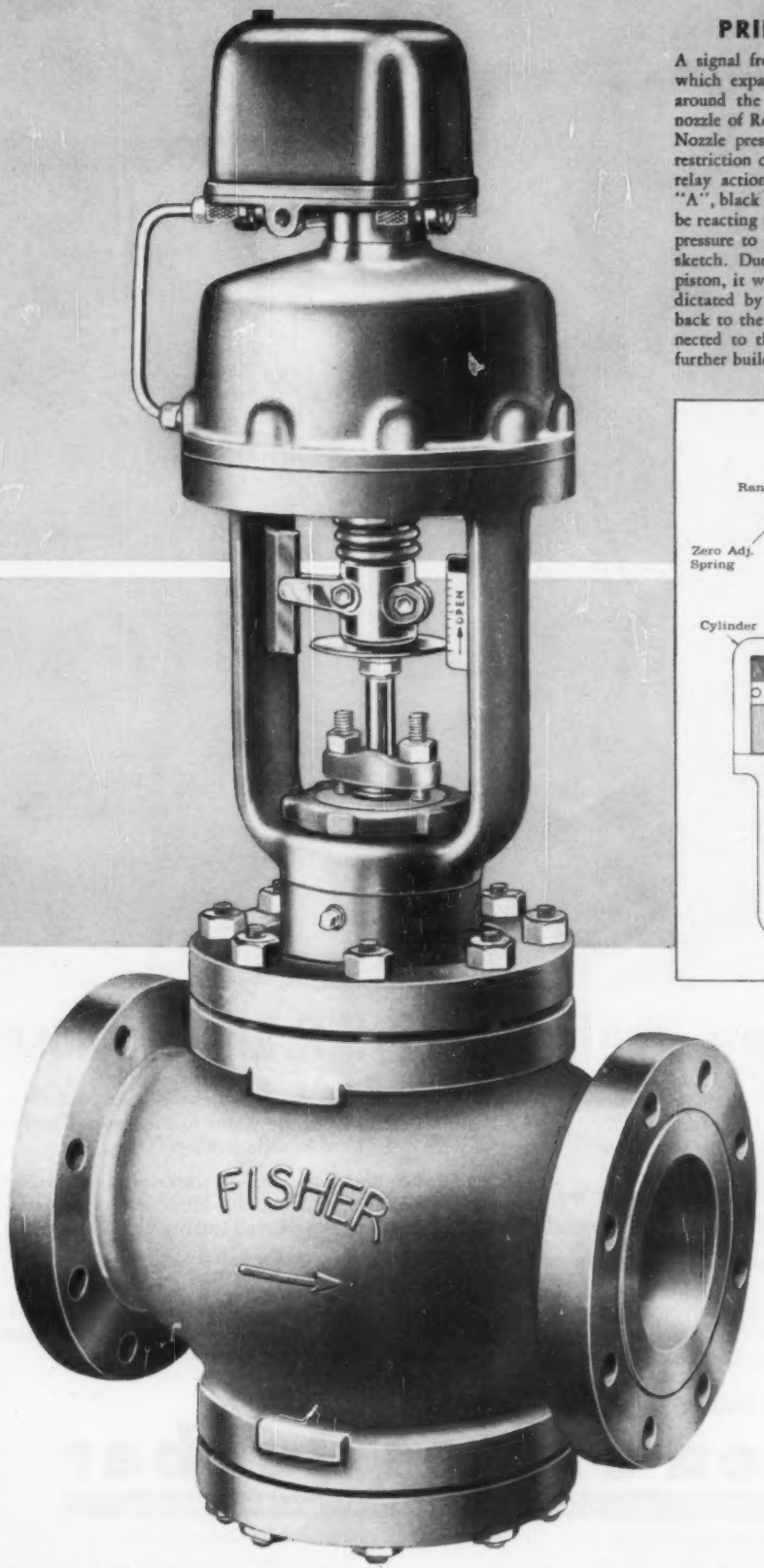
Coraopolis, Pa. / Woodstock, Ontario / London, England

Main Office and Plant: MARSHALLTOWN, IOWA

FISHER® Controls

SINCE 1880

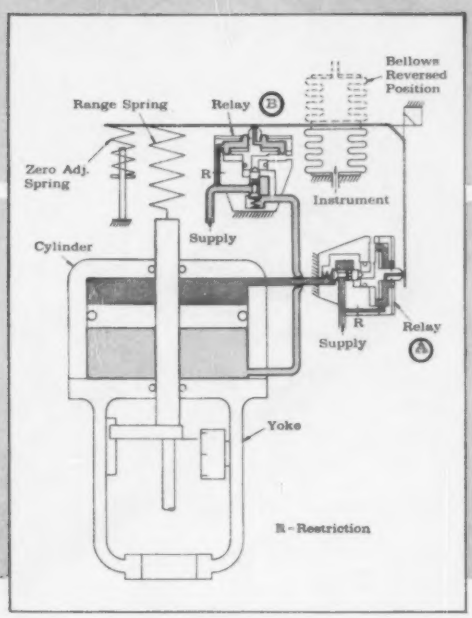
PNEUMATICALLY OPERATED PISTON...



Exterior view of high pressure actuator. Type 470 mounted on a Design "A" body.

PRINCIPLE OF OPERATION

A signal from the controller is received by the bellows which expand to move the beam. The beam will pivot around the fixed point and simultaneously uncover the nozzle of Relay "B" and cover the nozzle of Relay "A." Nozzle pressure will increase in Relay "A" due to the restriction created by the beam over the nozzle. Through relay action, the air pressure to the top of the piston, "A", black in the sketch, will be increased. Relay "B" will be reacting to the change in beam position to decrease the pressure to the under side of the piston, "B", red in the sketch. Due to the unbalanced pressures acting on the piston, it will move down, changing the valve position as dictated by the controller. The piston movement is fed back to the beam by means of a range spring that is connected to the piston rod extension, thus preventing any further build-up of pressure in the cylinder.



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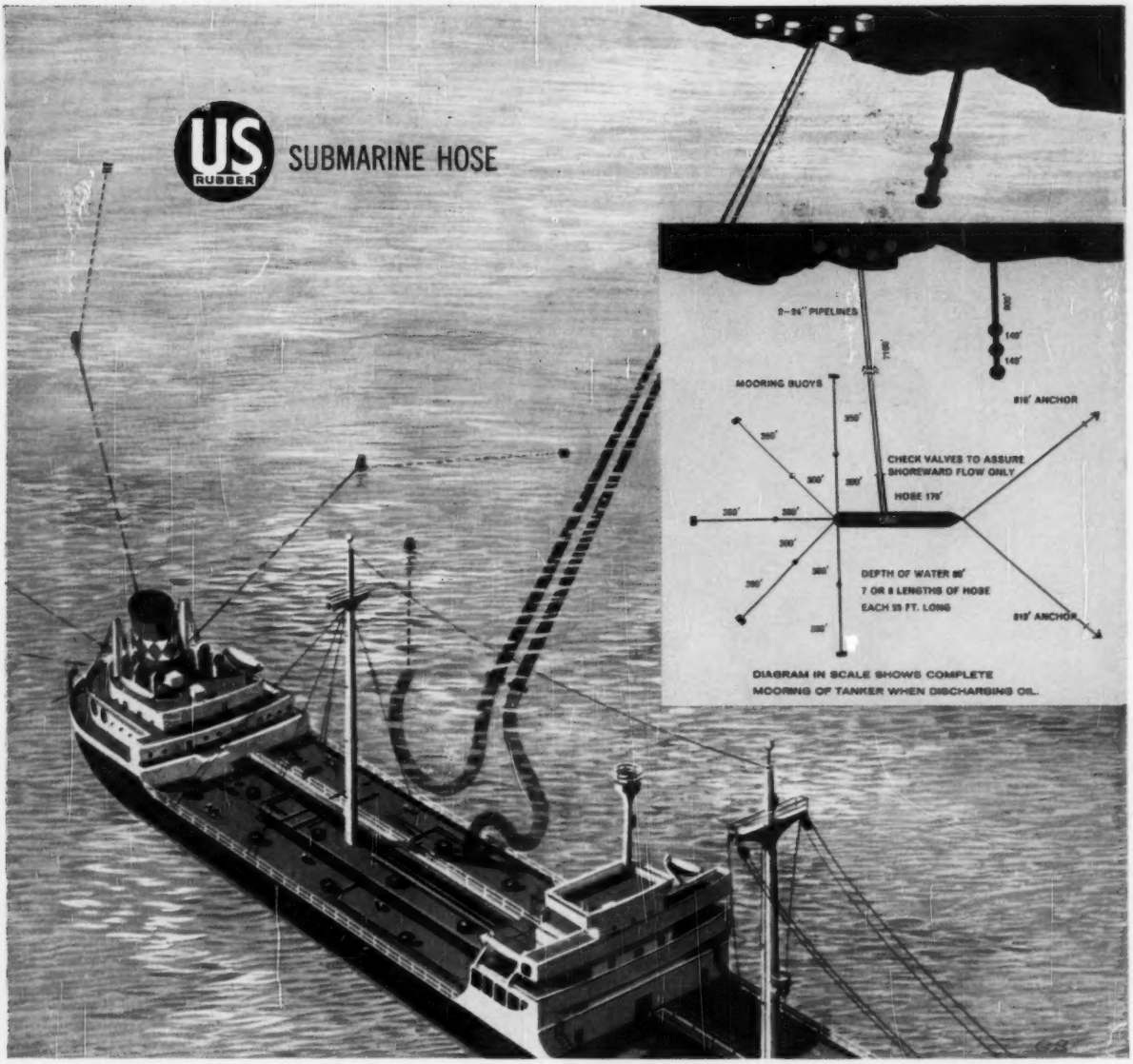

US RUBBER
SUBMARINE HOSE
2-24" PIPELINES
MOORING BUOYS
816' ANCHOR
CHECK VALVES TO ASSURE SHOREWARD FLOW ONLY
HOSE 179'
DEPTH OF WATER 80'
7 OR 8 LENGTHS OF HOSE EACH 55 FT. LONG
816' ANCHOR
DIAGRAM IN SCALE SHOWS COMPLETE MOORING OF TANKER WHEN DISCHARGING OIL.

From tanker to shore...the hook-up is U.S. Amazon Hose

The only submarine unloading point for oil tankers on the East Coast is at the Northville Dock Corp., Long Island, N.Y.

The operators say that submarine unloading would be impossible without hose of this character. Foreign and domestic tankers use this undersea hose (7100 feet offshore) as a hook-up to pipelines discharging heavy and light fuel oil directly into storage tanks on shore. Expensive dock and wharfage facilities are eliminated. *The tankers are moored at sea.*

The U. S. Amazon® Hose H2323 in use here resists the corrosive action of salt water and the turbulent action of swift tides. Its lightness and flexibility enable crew members to make it fast to the deck headers in record time. Also it curves easily from the water to the deck. There is never any sharp bend to impede flow.

Similar installations for other oil companies are located at world-wide points, proving the soundness of the construction features and the over-all quality of U. S. Amazon Hose.

• • •

When you think of rubber, think of your "U.S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

Mechanical Goods Division

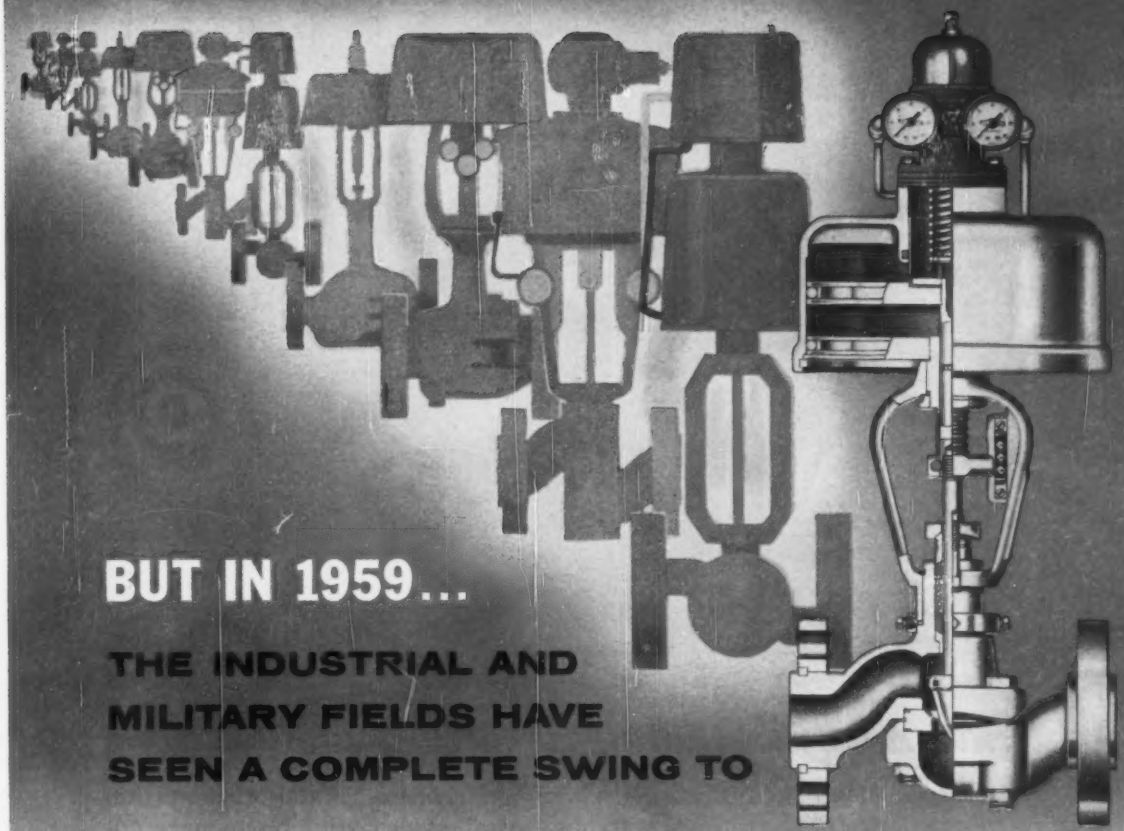
United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

IN 1948...THEY SAID IT COULDN'T BE DONE

...that split body, single seat construction would never be the accepted design for industrial or military control valves.



BUT IN 1959...

THE INDUSTRIAL AND MILITARY FIELDS HAVE SEEN A COMPLETE SWING TO

CONTROL the ANNIN WAY

In 1948 split body construction and powerful high speed, precise positioning pneumatic piston actuators were available from only one source—Annin. Today, more than a decade of accumulated experience in this type of valve design makes Annin features and performance records the best in the valve industry. Contrary to published statements by critics ten years ago, Annin-type construction is now available from many sources. But when tempted to consider *mere-replicas* of Annin valves, remember this—they might give you a few Annin features, but when you specify Annin Valves you get them all!

Annin VALVES

THE ANNIN COMPANY
1040 South Vail Avenue
Montebello, California

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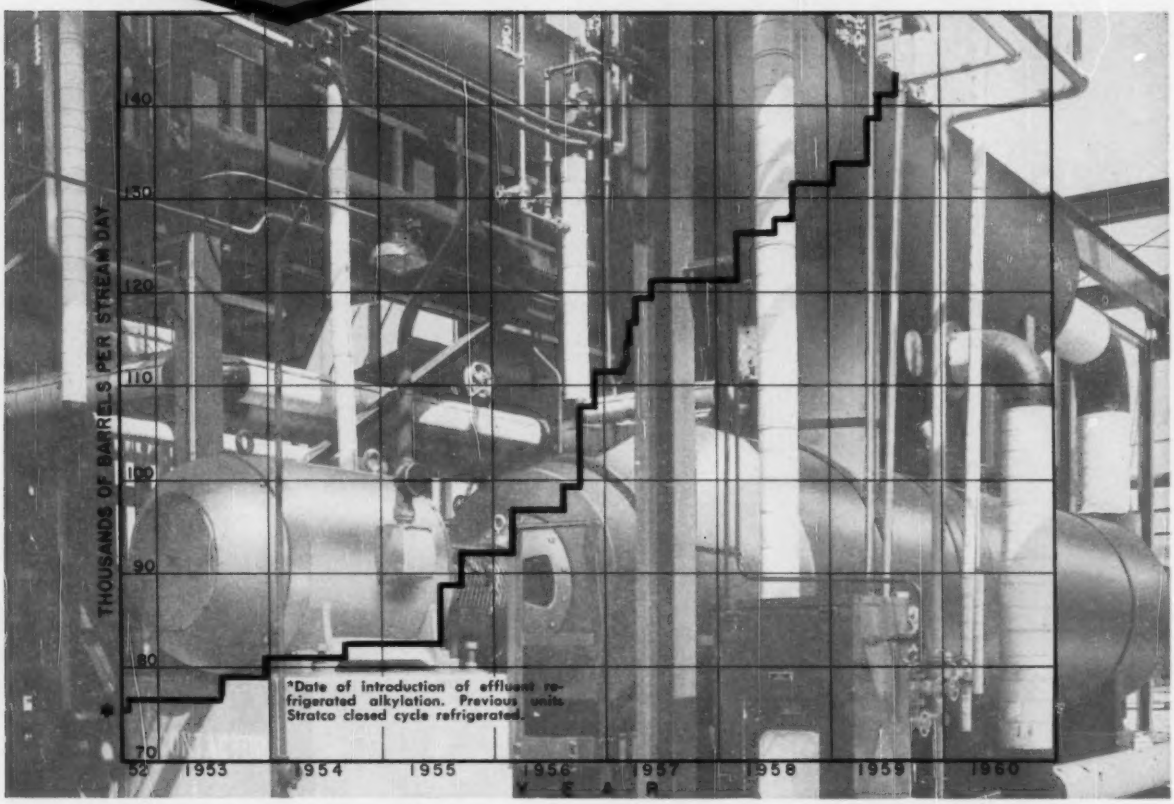
STRATCO
Reg. U. S. Pat. Off.

EFFLUENT REFRIGERATED ALKYLATION*



Charting An Outstanding Record of Installations

Which type of alkylation process is the most economical and efficient? According to a majority of the refiners who have installed alkylation plants in recent years, the answer is Stratco Effluent Refrigeration. The chart above traces the growth of Stratco Effluent Refrigeration since the process was introduced in late 1952. Each step on the graph indicates another plant contracted and its capacity. In this short period of time 46 units, with a total design capacity of 64,220 BPSD have been installed in 23 plants throughout the world. The trend toward effluent refrigerated alkylation is readily apparent. The Stratco process may be used to alkylate isobutane and propylene, butylene or amylene, either separately or as combined streams. Flow diagrams and electronically computed heat and material balances are available quickly and without charge from Stratco.

REPRESENTATIVES

D. D. Foster Co., Pittsburgh
D. D. Foster Co., S. Charleston, W. Va
Lester Oberholtz, Los Angeles
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The Rawson Co., Inc., Baton Rouge
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★ Licensed by Stratford Engineering Corporation

We cooperate with your contractor in plant design

STRATFORD ENGINEERING Corporation

612 W. 47th St. — Petroleum Refining Engineers — Kansas City 12, Mo.

TO MAKE ANY PLANT SAFER

ORBIT VALVES

ORBIT FORGED STEEL VALVES

ORBIT VALVES installed as "stop" valves in a compressor installation at a large natural gasoline plant in Texas. Compressor is driven with rich oil from four absorbers.

The Orbit Valve's positive closure and non-lubricated feature is ideal for use with pressure regulators, meters, reflux pumps, compressors and similar equipment in areas where repairs must be carried out from time to time. Wherever Orbit Valves are installed, you are assured a safe atmosphere for dismantling equipment and do not have to worry about valve leakage that could create a hazardous working area.

SIZES: 1″, 1½″, 2½″, 3″ and 4″ ASA 300-lb. through 2500-lb. full opening flanged and screwed ends. Venturi opening available in sizes: 2″, 2½″, 3″, 4″ and 6″ ASA 150-lb. through 2500-lb. flanged ends only.

SOURCE: Through your favorite supply house.

LITERATURE: Write Department B for Catalog 58-B.

ORBIT VALVE COMPANY

P. O. BOX 699. TULSA. OKLAHOMA
PHONE LUTHER 4-4761. TWX TU 925

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Protected by L. W. Blazecrete—this structure was virtually undamaged by 2 to 6 hours of *direct* flame exposure

Protected by Johns-Manville L. W. Blazecrete . . .

vital equipment is undamaged by 3 days of explosive fire!

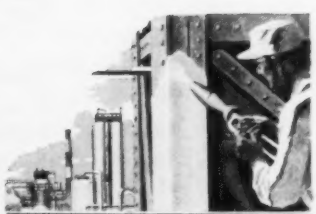
AFTER MORE than seventy hours of fire and explosion at one of the world's most modern thermofor catalytic plants, damage was estimated at nearly 8 million dollars.

Yet the flames didn't destroy the entire plant. Vital equipment, key structural members and control areas . . . made fire safe by Johns-Manville L. W. Blazecrete® . . . were virtually undamaged. This simple, low-cost protection paid for itself countless times over . . . helped get the refinery back on line many months sooner.

In your plant, too, Johns-Manville L. W. Blazecrete can save you money . . . for fire control and for lining high-temperature equipment.

A hydraulic-setting refractory—Johns-Manville L. W. Blazecrete is quickly, easily applied to equipment and structural members . . . and to linings of high-temperature equipment. For troweling, just mix L. W. Blazecrete with water as you'd mix ordinary concrete—then slap trowel in place. When gunned, L. W. Blazecrete adheres readily with a minimum of rebound loss. Whether used for fire protection or for linings—L. W. *Blazecrete lasts!*

Find out more about this newest of fire protection ideas, and about the application of L. W. Blazecrete throughout the petroleum industry. Write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.



Gunned in place or slap troweled L. W. Blazecrete is the ideal material for refractory linings. It gives you an unusually strong, dense and homogeneous lining . . . ready for use within 24 hours.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

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From the wellhead through the refinery gate BRIDGEPORT TUBES HELP CARRY THE LOAD

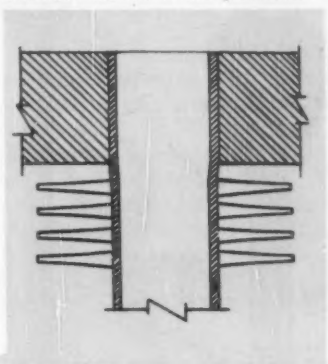
Right from the wellhead—Bridgeport is in the oil and gas production picture with aluminum, brass and copper base alloys in corrosion-resistant, single-wall and duplex tubes.

In natural gas production, for example, air-cooled heat exchangers at the wellhead do an around-the-clock job in both radiating the heat from the compressor engine and cooling the compressed gas before it is sent on its way to the gathering stations.

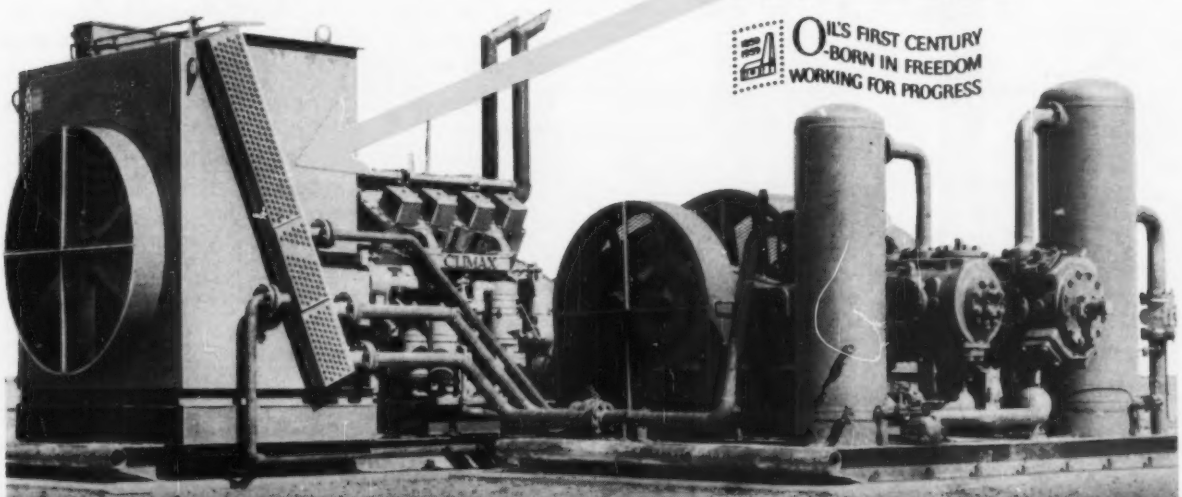
The air cooler illustrated here is manufactured by Air-X-Changers, Inc., Tulsa, Oklahoma. This model uses aluminum fins on Bridgeport Arsenical Admiralty condenser tubes. The tube bundles are mounted in a chamber, and fan-blown air across the finned surface cools either the compressor engine jacket water or the interstage and after-stage compressed gas. Bridgeport Inhibited Admiralty tubes are generally preferred for this type of service because of their corrosion resistance to both water and gas. And Bridgeport Aluminum Fin Stock is specially engineered for applications like this.

The range of Bridgeport condenser tube alloys—both single wall and duplex—is equaled by our vast experience in dealing with the special corrosive media encountered in the oil industry. This combination of quality products and technical engineering service pays you *all along the line.* Learn more about the benefits of Bridgeport Tubes and Technical Service for your applications. Write Dept. 5301.

Cross section of Air-X-Changer tube shows it expanded into tube sheet and individual aluminum fins positioned.



OIL'S FIRST CENTURY
-BORN IN FREEDOM
WORKING FOR PROGRESS



BRASS Bridgeport CO.

BRIDGEPORT BRASS COMPANY

Bridgeport 2, Conn. • Sales Offices in Principal Cities

Specialists in Metals from Aluminum to Zirconium

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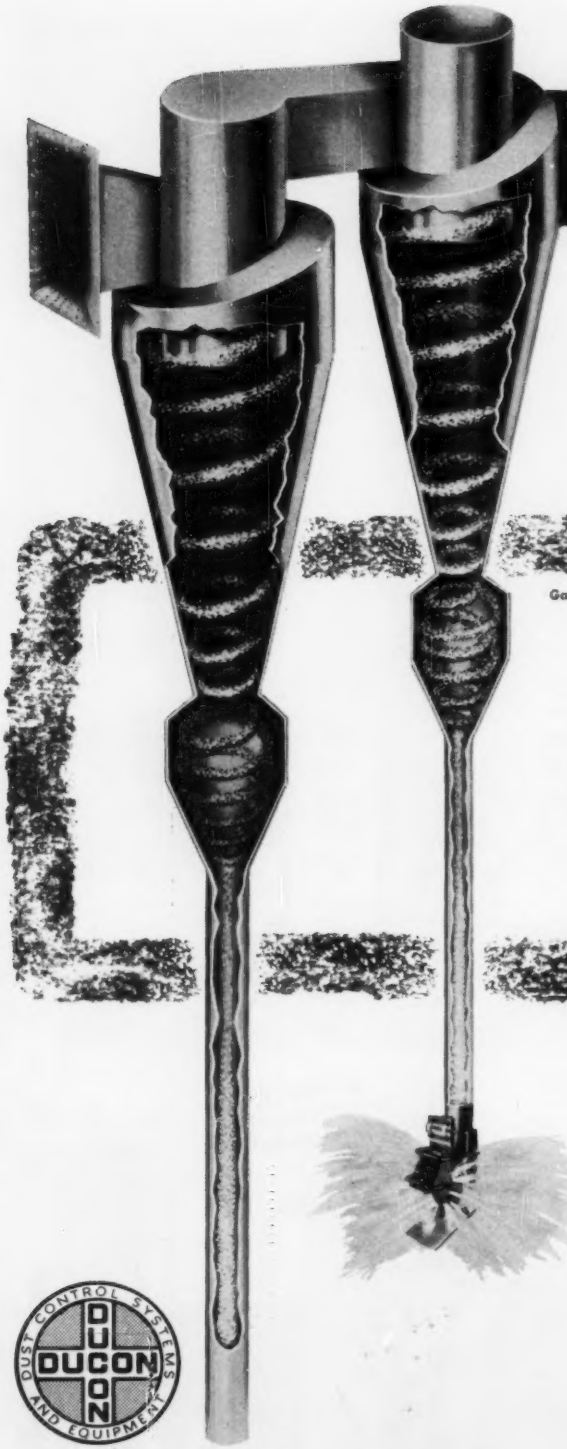
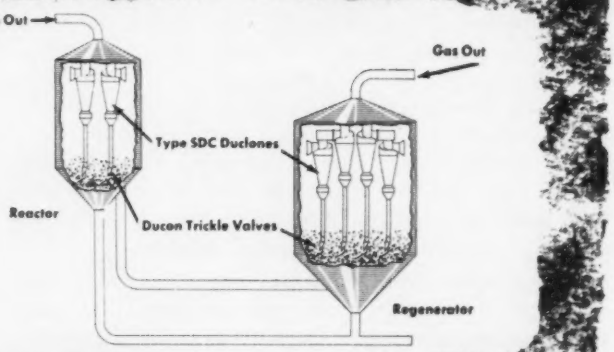


. . . in catalyst recovery

Type *SDC* DUCLONES assure

- ***HIGH EFFICIENCY***
- ***LOW PRESSURE LOSS***
- ***LONG SERVICE LIFE***



Ducon Type SDC Catalyst Recovery Duclones have earned the approval of the world's leading refineries for their effectiveness in catalyst recovery and other fluid bed processes.

The exceptional performance of Type SDC Duclones is the result of 6 unique design features:

1. Helical Inlet to reduce turbulence
2. Steep Cone for improved dust separation
3. Dust Trap to reduce entrainment
4. Scroll Outlet to provide low resistance, tangential gas exit
5. Small Diameter for high efficiency
6. Vortex Shield to reduce entrainment of dust in the upward flowing gas stream.

For additional information on Type SDC Duclones send for Bulletin C-2058.

DUCON — DUST CONTROL SYSTEMS AND EQUIPMENT

the name in DUst CONtrol

THE Ducon COMPANY INC.

147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK

Canadian Branch:
THE DUCON COMPANY of CANADA, Ltd.,
1131 Pettit St., BURLINGTON, ONTARIO

CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

In the design of these MEA Absorbers and Strippers

INTALOX SADDLES

- **Saved 20% in height**
- **40% in gas pumping costs**

GEEC The Gas Equipment Engineering Corporation of Mount Vernon, N. Y. designed and erected a 30 ton-per-day CO_2 generating plant. Two six foot diameter columns were used for absorbing carbon dioxide gas using MEA as the solvent. By using INTALOX Saddles for the tower packing, it was possible to reduce the tower height 20% below what would have been required with Raschig Rings.

Not only was the capital cost greatly reduced but the columns performed even better than design requirements. Operating costs were also less because the appreciably lower pressure drop led to a 40% reduction in gas pumping expense. In addition, the greater-than-design scrubbing efficiency led to increased CO_2 recovery.

In mass transfer operations involving packed towers the use of Intalox Saddles almost invariably means increased capacities, lower pressure drops, and, of course, lower initial and operating costs.

U. S. STONEWARE

AKRON 9, OHIO

OUR 100th YEAR

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INTALOX SADDLE PACKING

Would you like to know more about INTALOX SADDLES? Write for Bulletin S-29R

388-P

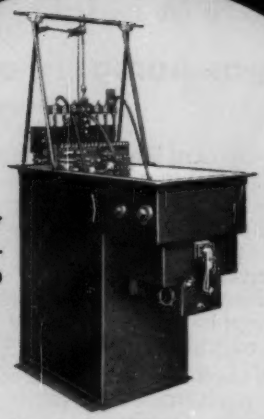
For more data on advertised products, use Readers' Service Cards, last page.

EC&M's LINE OF HIGH VOLTAGE STARTERS GIVES YOU

*EXACTLY the Right Starter for Any Location!**

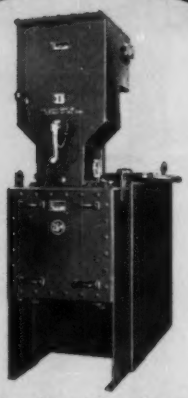
* Hazardous Location, Class I, Group D, Divisions 1 and 2

TOTALLY OIL-IMMERSED



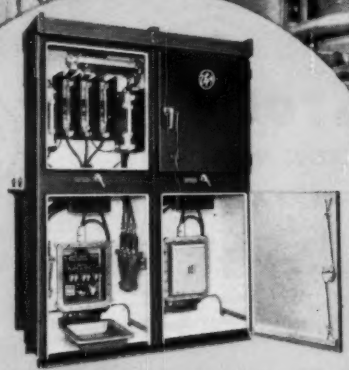
Type AT Combination Starter shown with Contactor and Overload Panel raised above the oil level without disconnecting any bolts or leads—in NEMA 3R enclosure for outdoor mounting, available in 50,000 KVA (certified) interrupting capacity.

OIL-IMMERSED



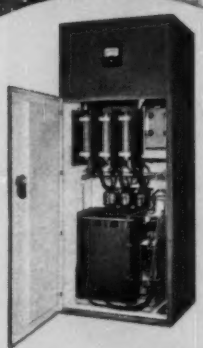
Type AM Combination Starter in NEMA 3R enclosure for indoor or outdoor locations—available in 50,000 KVA (certified) interrupting capacity —and VALIMITOR.®

OIL-BREAK



Type AH Combination Starter in NEMA 1 or 3R enclosures for indoor, outdoor or pressurized control room—available in 3 interrupting ratings, 50,000 KVA—POWER FUSED—and VALIMITOR.®

AIR-BREAK



Type AFG Combination Starter for Pressurized Control Rooms. Built in Class E1, Class E2 and VALIMITOR.®

For complete information write for Bulletin 8131-L

SQUARE D COMPANY

EC&M DIVISION • CLEVELAND 28, OHIO

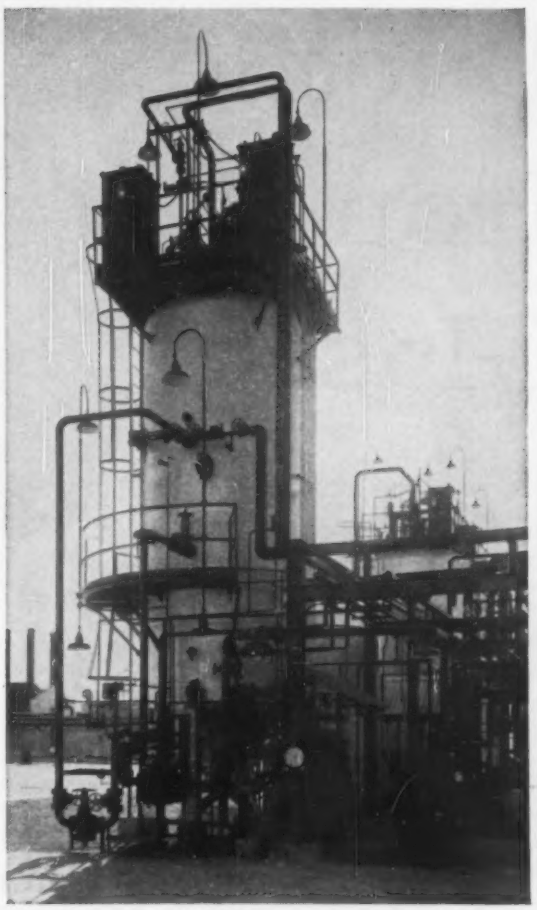
wherever electricity is distributed and controlled

7928-R

PRODUCT IMPROVEMENT WITH

PETRECO ELECTROFINING*

the modern, efficient, low-cost way to clean jet fuels, burning oils, pipeline products



ELECTROFINING Precipitation is one of the most versatile processes ever developed for the removal of such contaminating factors as sea water, fouled water, iron sulfide, and sediment from jet fuels, burning oils and other finished pipeline products.

Jet fuels purified in ELECTROFINING Precipitation Equipment contain 1 mg./liter, or less, of solids. This low solids content eliminates solids-caused flame-outs, increases engine and fuel-filter life . . . burning oils retain their true color, are sediment free . . . pipeline products are not contaminated by water and sediment, simplifying pipeline maintenance.

CHECK ELECTROFINING'S 4-WAY ADVANTAGES FOR YOUR OPERATION

COMPACT Offers better treatment, more uniform products than conventional agitation and settling systems—yet does its job in less space, requires less pumps, pipes, fittings, ground space.

PRECISE Completely eliminates guesswork. Optimum treating conditions, based on pre-commercial pilot tests, are set on automatic controls, resulting in continuous operations under consistent, controlled conditions.

FLEXIBLE Compactness and precision control combine to offer a new standard in versatility. ELECTROFINING Equipment can be placed at the delivery end of a pipeline or at the starting end. It can be installed at an airport or on an aircraft carrier as well as in a refinery.

ECONOMICAL The cost of ELECTROFINING Precipitation Equipment is many times less than that of treating methods incapable of delivering comparable results. And, compared to the expense and hazards of contaminated products, or the nuisances of air and stream pollution, its cost is negligible.

For the complete dollar, and sense, story of ELECTROFINING, write or call . . .

*ELECTROFINING *is a registered trademark of Petrolite Corporation*

DT-59-2

PETROLITE CORPORATION

PETRECO DIVISION

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1390 East Burnett Street (P. O. Box 7216), Long Beach 7, California

CANADA: Petreco, 4528 Stanley Drive, Calgary, Alberta

ENGLAND: Petrolite Limited, 46 Mount Street, London, W. 1.

VENEZUELA: South American Petrolite Corporation, Hotel Avila, Caracas

REPRESENTATIVES

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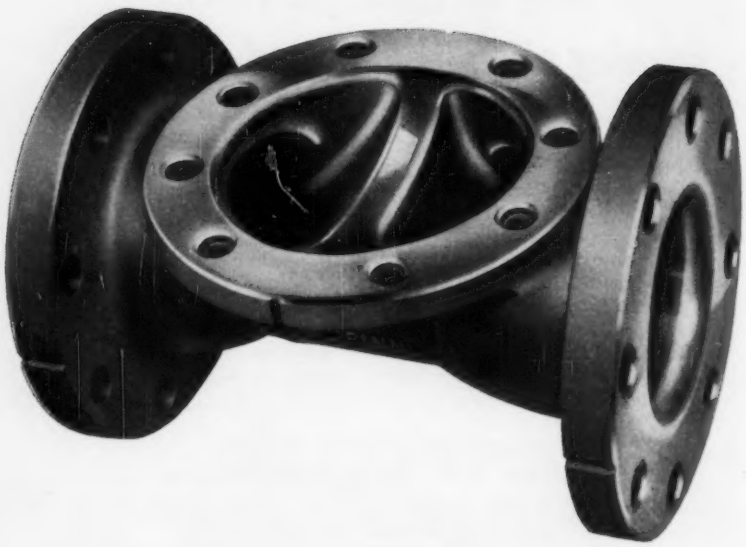
COLOMBIA: South American Petrolite Corporation, Calle 19, No. 7-30, Office 807, Bogota
ITALY: O. Wagner, 149 Via Nemorense, Apt. 1, Rome, Italy
JAPAN: Chiyoda Chemical Engineering and Construction Company, Ltd., Tokyo Bldg., No. 3, Marunouchi 2-Chome, Chiyoda-Ku, Tokyo, Japan
KUWAIT: F. N. Dahdah, Box 1713, Al Kuwait
MEXICO: R. E. Power, Sierra de Mijes, No. 125, Mexico D. F.
NETHERLANDS: F. E. C. Jenkins, Hoefbladlaan 134, The Hague
TRINIDAD: Neal and Massy, Ltd., Port of Spain, P. O. Box 544

For more data on advertised products, use Readers' Service Cards, last page.

Now...you can have Grinnell-Saunders Diaphragm Valves of

Ductile Iron with Glass-Lined Bodies



After long research, Grinnell has available top quality, corrosion-resistant glass lined bodies for its line of rugged ductile iron valves.

EXTRA TOUGHNESS The greater toughness of ductile iron resists impact, torsion, line strains and thermal shock. Grinnell-Saunders valves of ductile iron handle severe service requirements where both internal and external impact shocks may be expected, and where piping stresses from rapid heating and cooling occur.

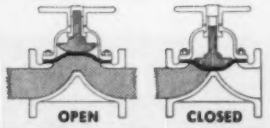
ECONOMY Approved and used by leading industries, ductile iron offers many of the benefits of cast steel at a lower price.

Of particular importance to users of Grinnell-Saunders valves is that ductile iron bodies can now be *glass-lined*—a procedure not practical with cast steel bodies.

WIDE SELECTION Body linings: glass, rubber, neoprene. Diaphragms: soft natural rubber, natural rubber, white synthetic rubber, neoprene, reinforced neoprene, butyl, Hycar, Teflon, Kel-F, PVC (polyvinyl chloride), polyethylene. Bonnet materials: ductile iron, grey iron. Bonnet styles: handwheel (non-indicating stem or indicating stem), chain wheel, lever for quick operation, and sliding stem for a wide selection of power operated topworks.

Important features of the Grinnell-Saunders Diaphragm Valve

- Diaphragm completely isolates operating mechanism from the fluid in the line
- Diaphragm lifts high for full, streamline flow in either direction
- Diaphragm effects positive, leak-tight closure
- Diaphragm easily replaced without removing valve body from the line

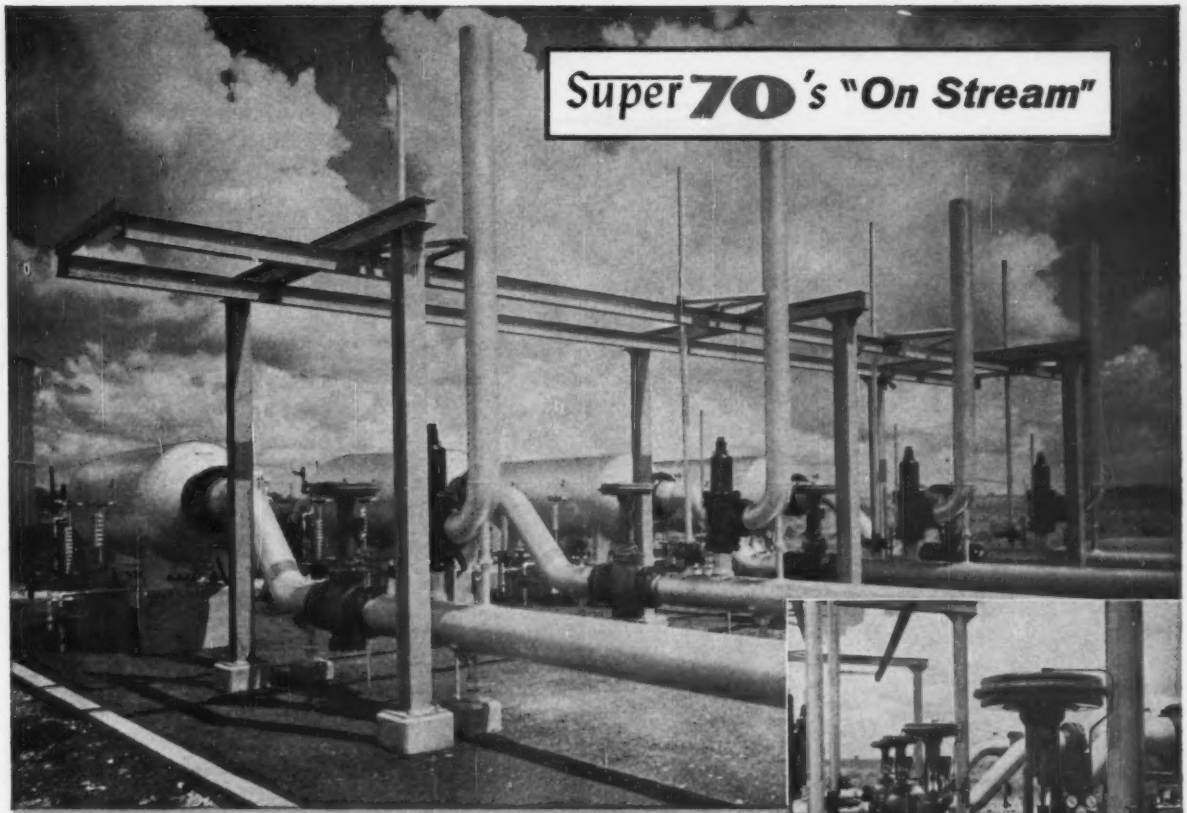


GRINNELL-SAUNDERS DIAPHRAGM VALVES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

For more data on advertised products, use Readers' Service Cards, last page.



"Life-Blood" of a Large Refinery!

BS&B Super 70 Diaphragm Control Valves with Clamp Ring—Float Ring Body Closure.

This natural gas metering station feeds 100 MMSCF of gas per day to a large Gulf Coast Refinery. If it were necessary to shut down the station for repairs, operation of the refinery would be seriously impaired.

That's why engineers who designed the station wanted to be absolutely sure the control valves would function properly day in and day out under all operating conditions.

Because of their superior performance characteristics and rugged dependability . . . and because of BS&B's reputation for quality products and dependable service in the oil industry . . . BS&B Super 70 Control Valves were selected. Now "on stream", they are performing well in every respect.

BS&B Super 70 Valves are available in a complete range of sizes . . . with either clamp ring—float ring, or flanged—gasketed body closures. Specify them on your next job!

BLACK, SIVALLS & BRYSON, INC.

Controls Division,
Dept. 4-F1
7500 East 12th Street
Kansas City 26, Missouri

SUPER BS&B 70

For more data on advertised products, use Readers' Service Cards, last page.

WILFLEY Acid Pumps Cut DOWNTIME... MAINTENANCE COSTS

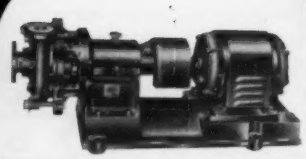
Wilfley's simplified, packingless design and rugged construction guarantee trouble-free operation . . . an important cost-saving advantage to economy-minded plant operators. They know, too, Wilfley Acid Pumps give them higher output and longer pump life.

WILFLEY ACID PUMPS

Pumping parts are available in a variety of metal alloys, as well as plastic, to cover a wide range of corrosive applications. 1" to 8" discharge sizes with 10 to 3000 GPM capacities and heads up to 200' and higher.

To give you maximum pumping economy every Wilfley installation is **JOB ENGINEERED**

Write, wire or phone for complete details.

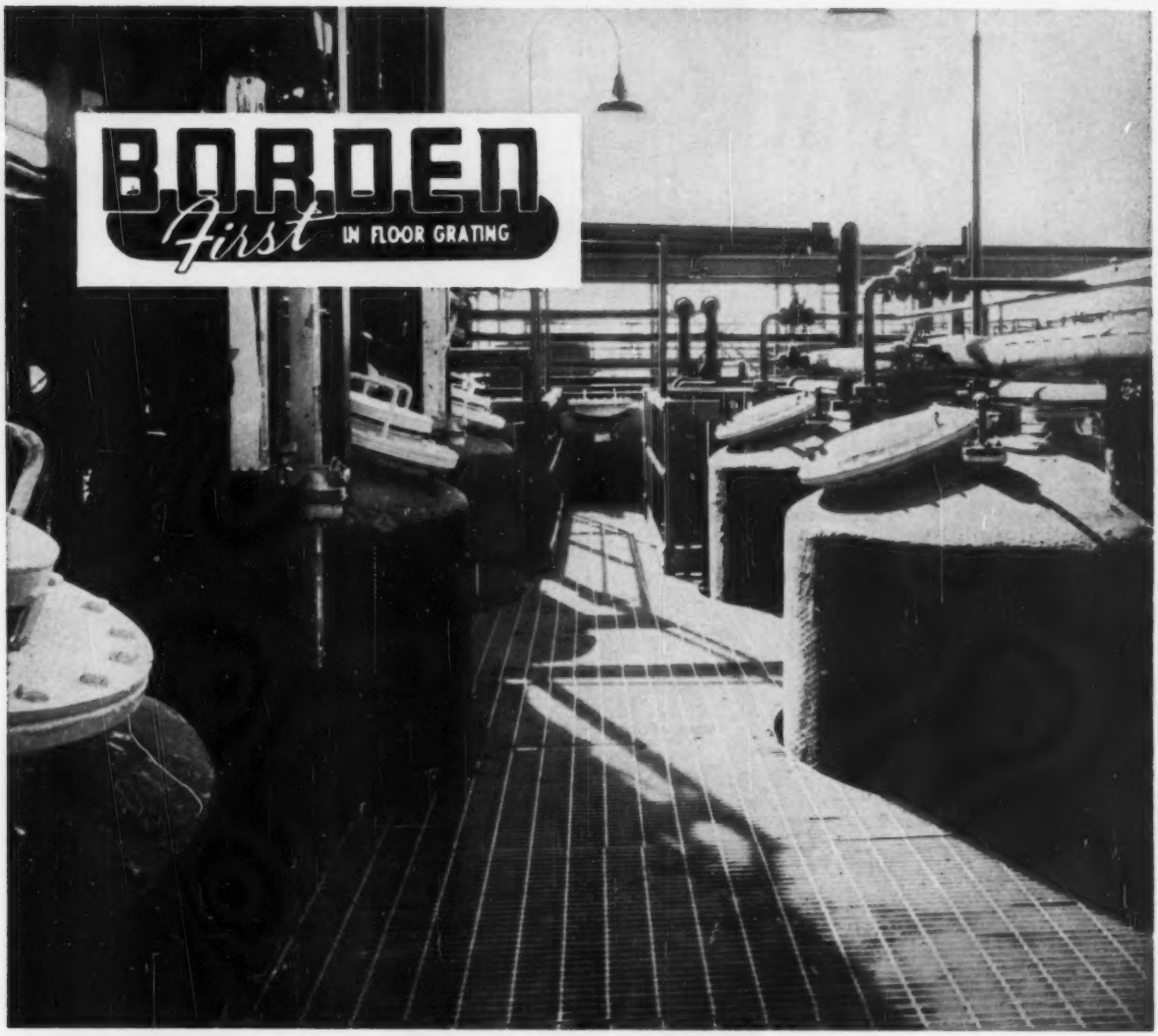


WILFLEY ACID PUMPS
"COMPANIONS IN ECONOMICAL OPERATION"
WILFLEY SAND PUMPS

A. R. WILFLEY and SONS, INC.

DENVER, COLORADO, U. S. A. P.O. BOX 2330

NEW YORK OFFICE: 122 E. 42ND ST., N.Y. CITY 17



HERE'S WHY THE BORDEN LABEL MEANS BETTER FLOOR GRATING . . .

BORDEN—First in Floor Gratings—is proud of its particular adaption and specialization in gratings for the refinery industry. **Borden's** well-known attention to detail and great familiarity with this special field guarantees complete satisfaction.*

Trouble-free installation is assured by **Borden's** Free Planning and Checking Service: All details and dimensions are carefully checked with the customer before fabrication; the component parts are individually marked for economical, accurate and speedy erection in the field.

*This applies to grating (usually stainless steel) for vessel and tower internals — such as grid trays etc. — as well as for strictly structural applications.

Write today for FREE
16-page catalog showing all basic types of grating; more than 30 dimensional drawings of subtypes; eight safe load tables for steel and aluminum grating.

BORDEN METAL PRODUCTS CO.

"Greatest name in gratings"

823 GREEN LANE ELIZABETH 2-6410 ELIZABETH, N. J.

Plants at: Union, N. J. – Leeds, Ala. – Conroe, Texas – Beeton, Ontario

BORDEN METAL PRODUCTS CO.

Gentlemen:

Please send me new 1960 BORDEN Catalog

NAME .....

TITLE .....

COMPANY NAME .....

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CITY AND STATE .....

For more data on advertised products, use Readers' Service Cards, last page.

Reactors withstand hot phosphoric acid 4 years

. . . 316L stainless steel protects them

Clad with Nickel-containing Type 316L stainless steel, these two reactors have been handling a 375°F phosphoric acid catalyst for 4 years.

. . . They're still doing well! No down time. Little maintenance.

The 313L stainless steel not only contends with phosphoric acid corrosion in this equipment . . . but also with thermal stresses and with abrasion from quartz packing.

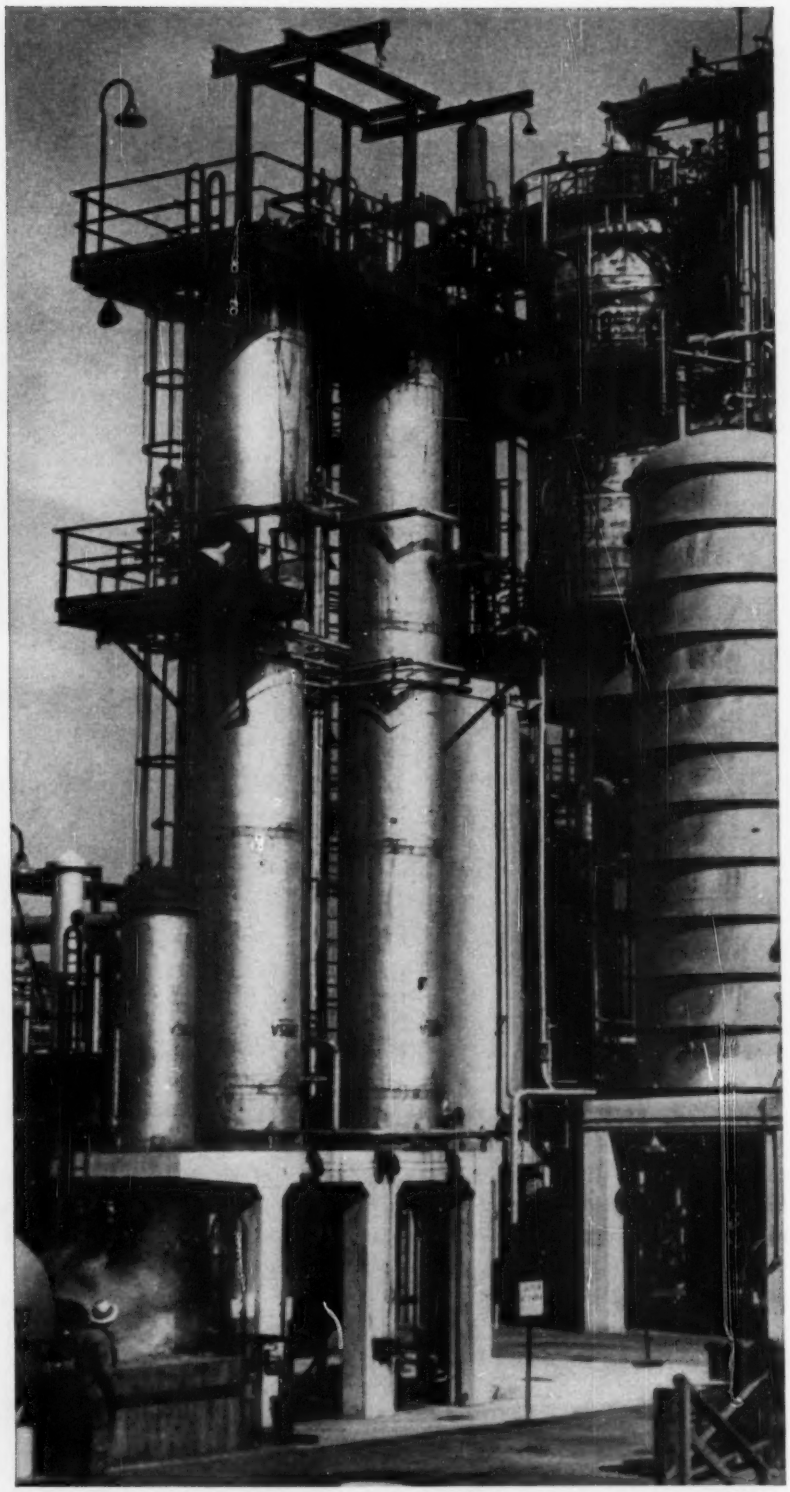
Nickel-containing stainless steels have an enviable record in refineries

Nickel-containing stainless steels reduce maintenance costs in many corrosive areas of refineries: in crude topping towers, in sulfuric acid lines of alkylation units, in furfural separation towers.

When you're designing equipment for handling corrosives, it will pay you to investigate the low-maintenance benefits of chromium-nickel stainless steels.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street INCO New York 5, N. Y.



Lukens Stainless-Clad Steel handles 375°F phosphoric acid for over 4 years. These polymerization reactors at the Standard Oil Company of British Columbia Limited Refinery in Burnaby, British Columbia, are protected from hot phosphoric acid and abrasion by Nickel-containing 316L stainless steel cladding.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

Why you can't afford cheap nozzles...

BORE OF NOZZLE IN INCHES	CU. FT. OF AIR PER MINUTE @ 80 LBS. PER SQ. IN.	H.P. REQUIRED TO MAINTAIN PRESSURE
3/8	191	34.76
13/32	225	40.95
7/16	260	47.32
15/32	299	54.42
1/2	340	61.88
9/16	430	78.26
5/8	532	96.82

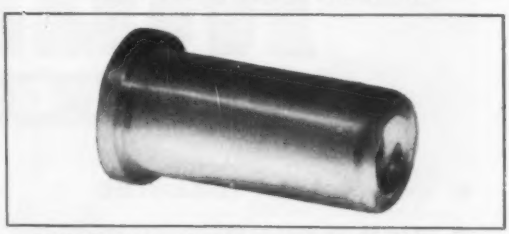
The chart tells the story.

Any pressure blast nozzle which wears rapidly greatly increases your compressed air bill. For example, when you start with a 3/8" bore nozzle at 80 lbs. blasting pressure, it will pass 191 cu. ft. of air per minute, requiring 34.76 H.P. However, when this nozzle has enlarged only 3/16" to 9/16" bore, you must supply 430 cu. ft. of air per minute to maintain the 80 lb. pressure. And you pay for 78.26 H.P. to develop this volume. And with ordinary nozzles, the difference between 3/8" and 9/16" occurs in only a few hours, or when manufactured abrasives are used, this can happen in a matter of minutes!

Now contrast the minimum guaranteed life of Norton NORBIDE* Pressure Blast Nozzles: 750 hours with silica sand . . . 1500 hours with steel shot or grit! Lined with light, tough Norton Boron Carbide — a compound exceeded in hardness only by the diamond — they maintain high-efficiency abrasive velocity *economically* throughout their life span.

Why blast away your profits with cheap nozzles? Get the most work out of both nozzle *and* air with NORBIDE Nozzles. Available with bores from 1/8" to 3/4"; lengths up to 6". For details write Norton Company, Refractories Division, 460 New Bond Street, Worcester 6, Mass.

*Trade-Mark Reg. U.S. Pat. Off. and Foreign Countries



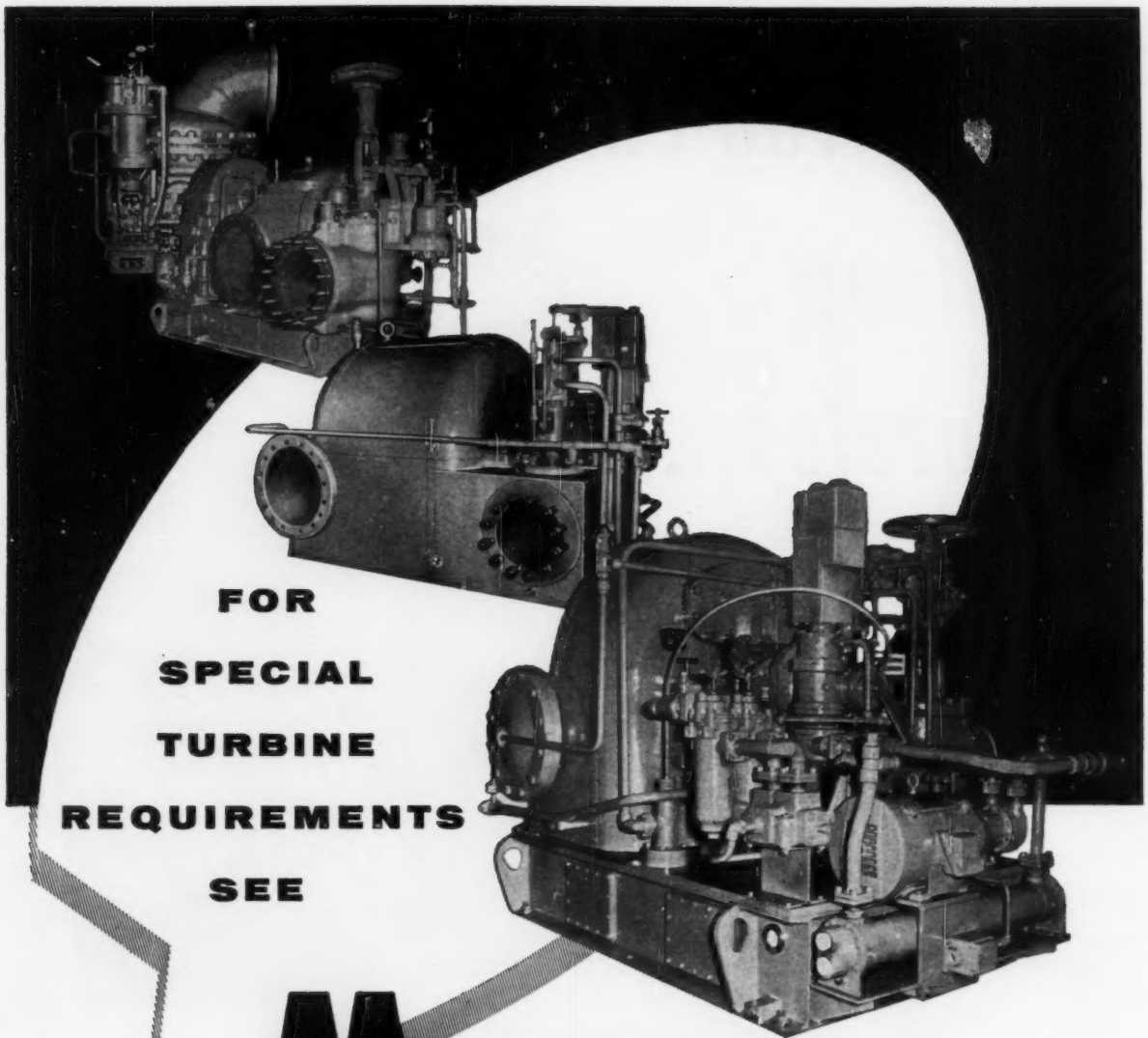
NORBIDE Pressure Blast Nozzles cut air costs 10% to 20%.

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

Making better products . . . to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — **BEHR-MANNING DIVISION:** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

For more data on advertised products, use Readers' Service Cards, last page.



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TURBINES

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- High Back Pressures
- High Speeds
- Variable Speed Ranges
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- Multi-Valve Designs
- Double End Gear Drives
- Vertical Shaft Turbines

Our nearest representative will help you solve your turbine requirements. His name gladly sent on request.

MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA

Builders of Steam Power Equipment for Nearly a Century

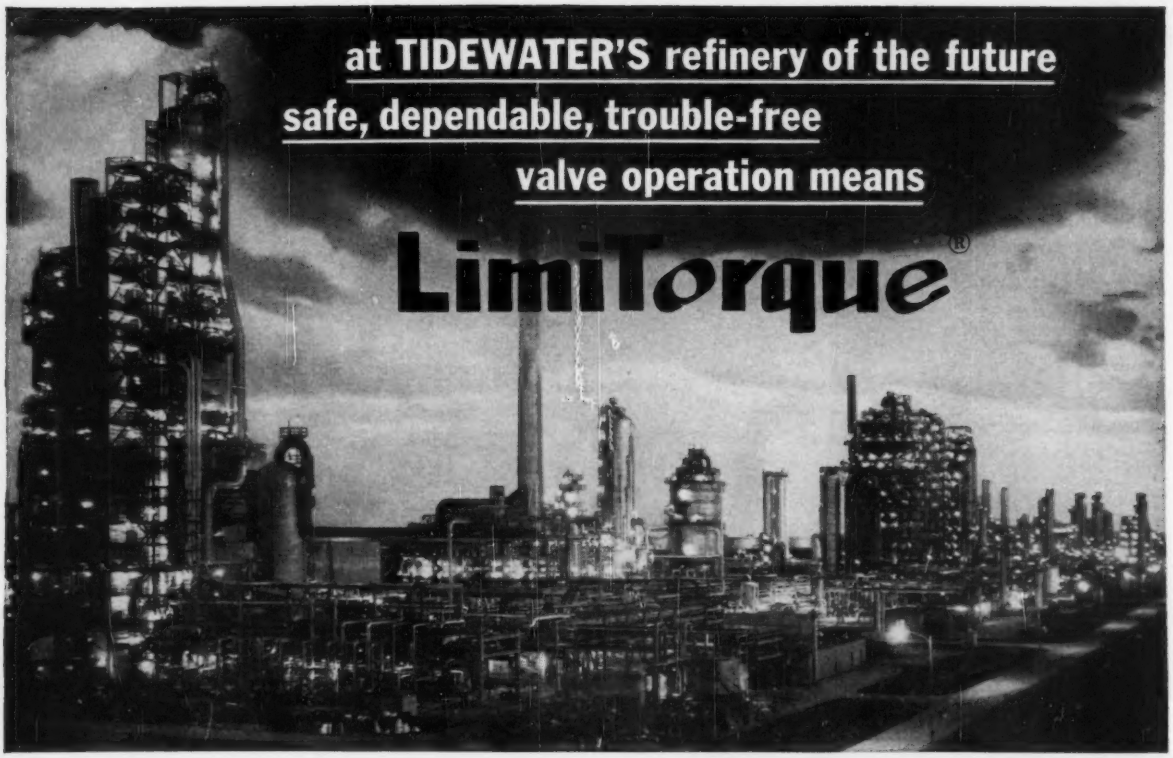
Pennsalt service helps you cash in on HYDROFLUORIC ACID alkylation

The striking savings you can get when you alkylate with hydrofluoric acid are a matter of record. And Pennsalt's long, specialized experience with AHF can help you take advantage of these savings. We'll show you how to handle, store and use Pennsalt AHF safely and confidently . . . advise you on valves, pumps, piping and materials of construction . . . help you with employee training programs . . . give you personalized technical assistance tailored to your needs. Ask your Pennsalt representative, or write for full information. Industrial Chemicals Division, PENNSALT CHEMICALS CORPORATION, Three Penn Center, Philadelphia 2, Pa.

New HF Handling and Data Book. Includes text, drawings, graphs, tables, photos. Write on your letterhead for Bulletin S-148.

See our complete listing in Chemical Materials Catalog

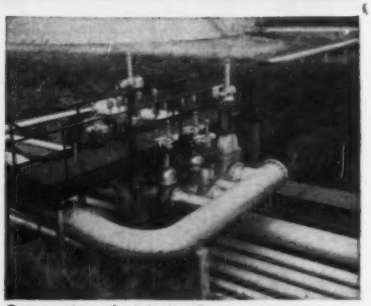
Pennsalt Chemicals
ESTABLISHED 1850



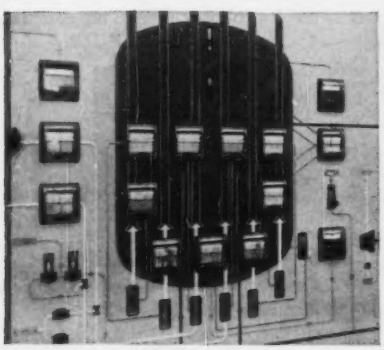
Here, at the World's newest and finest refinery where equipment standards are high . . . technology far advanced . . . six LimiTorque type S3 valve operators at the base of the big "cat", recycle catalysts around the clock . . . help maintain throughput capacity of 102,000 BPD.

In fact, in the refinery section alone 134 LimiTorque Motorized Controls provide safe, automatic, trouble-free valve operation. LimiTorque is more than proud to have played a part in this tribute to American ingenuity.

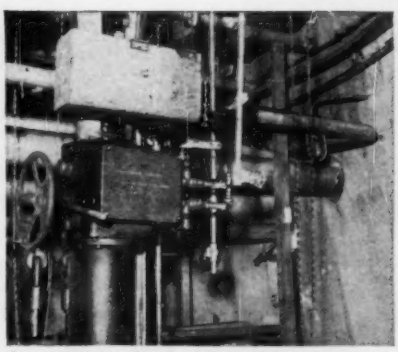
Wherever automatic, remote valve operation is required, LimiTorque will provide rapid, precise control under a wide range of operating conditions. Actuated by electricity, hydraulic pressure, air, or high pressure gas, LimiTorque can be readily field mounted on existing valves. For specific applications, contact your valve manufacturer or nearest LimiTorque representative.



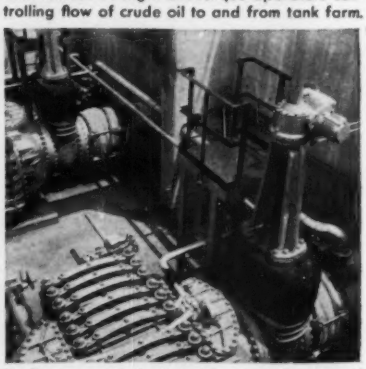
One section of eight LimiTorque operators controlling flow of crude oil to and from tank farm.



Automatic control panel for LimiTorque operated plug valves at base of cat cracker.



One of six LimiTorque S-3 specials regenerating catalysts at base of huge orthoflow fluid cat cracker.



LimiTorque motorized valve controls operate 36 in. valves on ten giant twin strainers.

THERE IS NO SUBSTITUTE FOR

LimiTorque®

PHILADELPHIA GEAR CORPORATION

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

For more data on advertised products, use Readers' Service Cards, last page.

You get these benefits when you install YARWAY GUN-PAKT EXPANSION JOINTS

Why do industrial plants, institutions, universities and central heating plants SPECIFY and INSTALL Yarway Gun-Pakt Expansion Joints?

Because with Yarway you get:

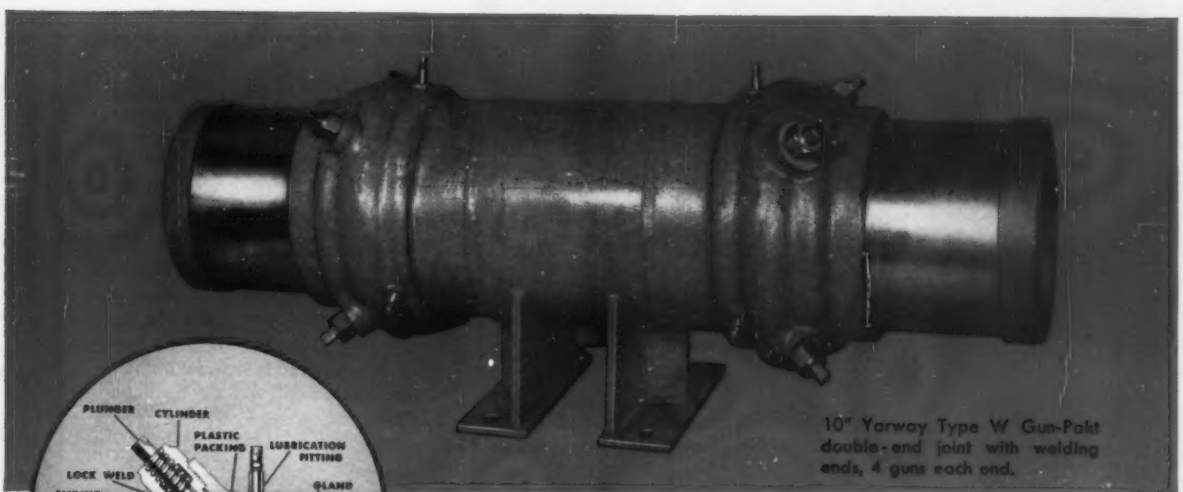
- **CONTINUOUS SERVICE**
  Costly shutdowns are eliminated. Packing is seldom necessary but may be added *under full line pressure*. No vents are necessary. Never needs repacking.
- **RUGGED DEPENDABILITY ALL STEEL CONSTRUCTION**
  Durable chromium plated seamless steel sleeves. No chance *of metal fatigue*. Wrought steel bases provide rugged, positive anchorage.
- **INTERNAL AND EXTERNAL GUIDES**
  Positive alignment of sleeve in stuffing box *—where it counts!*
- **LIGHT WEIGHT, STREAMLINED DESIGN**
  Requires less space to install—less space to maintain—smaller manholes.

Many Gun-Pakt joints have been *in service over 25 years with only nominal maintenance*—no major repairs or periodic overhauls. Maintenance costs are negligible—records show average to be one manhour and 65 cents worth of packing per joint per year. AND—NEVER A SHUTDOWN FOR REPACKING!

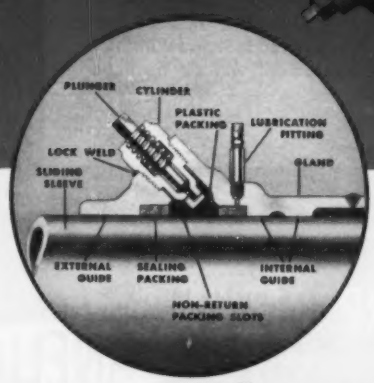
YARWAY field engineers are qualified to advise on installation and service—at no cost to you. Investigate today. Write for Bulletin EJ 1917 ('59).

FOR YOUR NEXT PIPELINE JOB—BE SAFE—BE SURE! SPECIFY YARWAY GUN-PAKT.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES



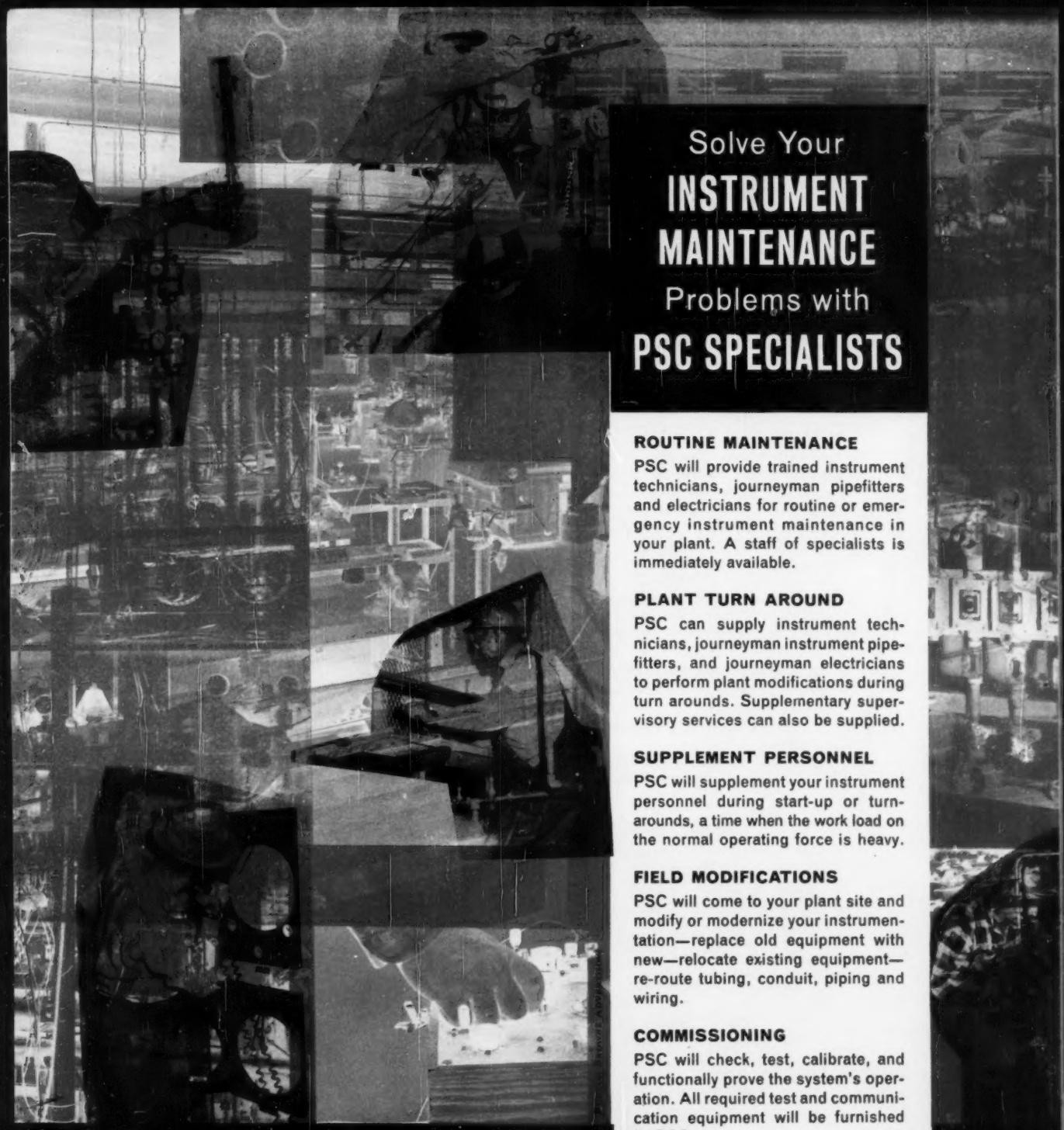
10" Yarway Type W Gun-Pakt double-end joint with welding ends, 4 guns each end.



Cross-section of Gun-Pakt feature. To add packing, just insert a plug and turn the plunger. Note non-return packing slots.

YARWAY GUN-PAKT

For more data on advertised products, use Readers' Service Cards, last page.



Solve Your INSTRUMENT MAINTENANCE Problems with PSC SPECIALISTS

ROUTINE MAINTENANCE

PSC will provide trained instrument technicians, journeyman pipefitters and electricians for routine or emergency instrument maintenance in your plant. A staff of specialists is immediately available.

PLANT TURN AROUND

PSC can supply instrument technicians, journeyman instrument pipefitters, and journeyman electricians to perform plant modifications during turn arounds. Supplementary supervisory services can also be supplied.

SUPPLEMENT PERSONNEL

PSC will supplement your instrument personnel during start-up or turnarounds, a time when the work load on the normal operating force is heavy.

FIELD MODIFICATIONS

PSC will come to your plant site and modify or modernize your instrumentation—replace old equipment with new—relocate existing equipment—re-route tubing, conduit, piping and wiring.

COMMISSIONING

PSC will check, test, calibrate, and functionally prove the system's operation. All required test and communication equipment will be furnished by PSC.

Is your instrument maintenance problem critical? Call on PSC's trained staff for immediate relief.

PSC® PANELLIT SERVICE CORPORATION

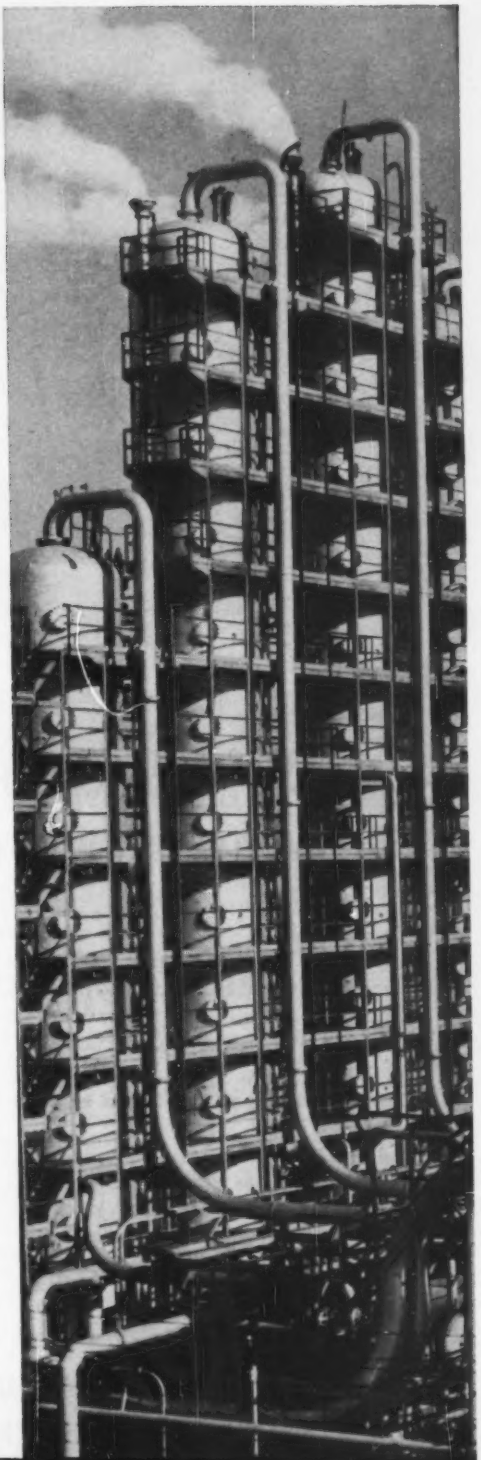
7401 No. Hamlin Ave., Skokie, Illinois
Phone: ORchard 5-2500

DIVISION OF PANELLIT

Annunciators • Control Panels • Data Systems • Contract Maintenance and Installations

Oakite ECP
engineered cleaning program

races through tower turnaround in under a day



Steaming and washing a 90 foot tower just to remove gas normally took two to three days at one refinery. Labor crews then brushed and scraped for several more days to strip a heavy, crusty deposit from walls, pans, downcomers and 36 trays. Cost of manual labor alone exceeded $2,800.

But with an Oakite ECP, circulation cleaning of the tower was recommended. The refinery pumped a hot Oakite solution through the tower for 12 hours, followed up with 2½ hours of hot and then cold rinses. That did it. The tower was gas-free and completely clean. Cost of materials: only $500.

WHAT IS OAKITE ECP? It's an *Engineered Cleaning Program* that stresses chemical cleaning. It's engineered specifically for your refinery, for your cleaning problems, and for each cleaning operation—tower by tower, valve by valve.

The Oakite engineer lends personal and experienced supervision to each phase of the program. He supplies detailed instruction based on practical knowledge of refinery cleaning needs. Each Oakite ECP is backed by a *laboratory* concentrating on chemical cleaning research, by *materials* known to make short work of refinery soils, by proved *methods*. Send for booklets. Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
SCIENCE

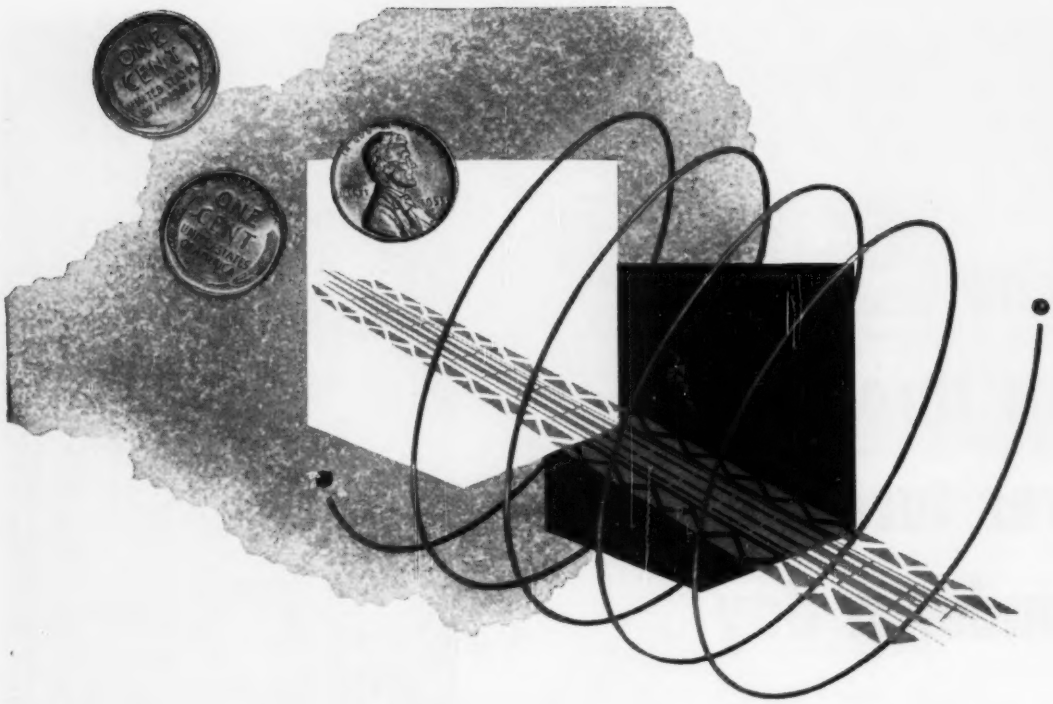
Technical Service Representatives in Principal Cities of U. S. and Canada

Export Division Cable Address: Oakite

In our 50th year.

Oakite ECP
your economy key

For more data on advertised products, use Readers' Service Cards, last page.



QO® FURFURAL OFFERS FLEXIBILITY, HIGH RECOVERY, AND LOW SOLVENT COST IN EXTRACTION OF BUTADIENE

QO Furfural has the unique ability to alter relative volatilities of butadiene and other C_4 hydrocarbons. This permits easy separation of compounds differing in degree of unsaturation.

Special advantages of using furfural include:

FLEXIBILITY: Furfural is effective in separating butylenes as well as butadiene, thus a furfural unit can be used to prepare both alkylate stock and butadiene. The process employs petroleum-type equipment, which can be adjusted to a variety of operating conditions.

HIGH RECOVERY: Good selectivity of the solvent assures high butadiene recovery; excellent stability of the furfural assures almost quantitative recovery of the solvent itself.

LOW SOLVENT COST: QO Furfural is produced in large quantities from agricultural residues—not from the valuable food or fiber portions of the plant. This helps keep prices low and stable.

QO Furfural is a proved, safe, low cost way of producing butadiene of highest purity. Write for information on extractive distillation and Bulletin 203-A entitled Physical Data on QO Furfural.

The Quaker Oats Company
CHEMICALS DIVISION

The Quaker Oats Company — CHEMICALS — QO — QUAKER CHEMICALS — DIVISION

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Room 540M 120 Wall Street,
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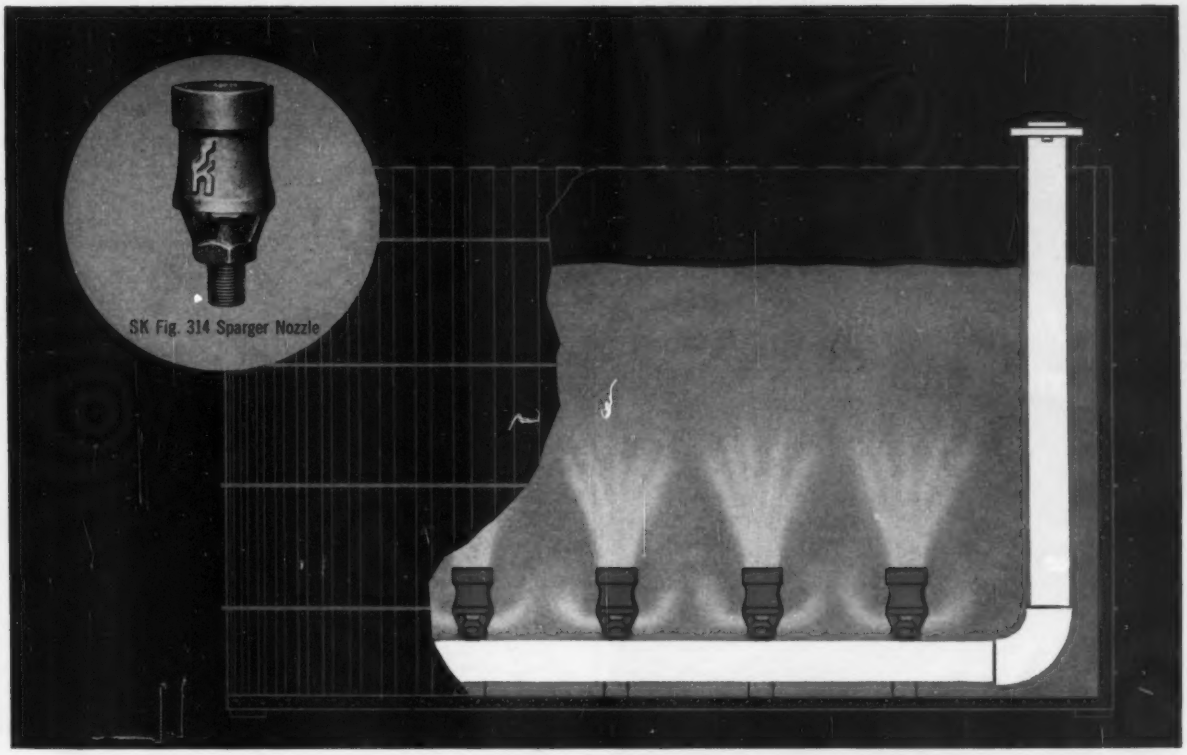
In Australia:
Swift & Company, Ltd., Sydney

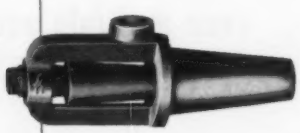
In Japan:
F. Kanematsu & Company, Ltd., Tokyo



HOW TO HEAT AND AGITATE LIQUIDS IN TANKS

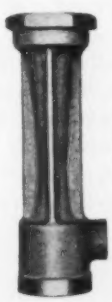
efficiently, economically, and with less noise

SK Fig. 301 Noiseless Heater for Tank Heating



SK Fig. 315 Circulating Heater for Tank Heating

SK Fig. 320 Continuous Heater for Pipe-Line Heating



SK Fig. 327 Slurry Heater for Pipe-Line Heating

Do it with plant steam and SK Steam Jet Heaters.

These Heaters utilize the jet principle to mix steam with a cold liquid, uniformly and without the noise and vibration usually associated with such operations. Since all of the heat in the steam is absorbed by the tank liquid being heated, operation is efficient. Because the jet action of the Heaters produces agitation and circulation, you need no additional equipment to perform these functions. Furthermore, since Steam Jet Heaters have no moving parts (except an adjusting spindle on some pipe-line types), you get long, trouble-free service without costly supervision and maintenance.

The illustration above shows tank heating being accomplished using SK Sparger Nozzles—one of the several types of Heaters offered by SK. Units of this type are ideal for use where uniform agitation is required over a large shallow tank area. In operation, a jet of steam issuing through the nozzle entrains tank liquid through the suction opening. Condensation takes place immediately upon mixing of liquid and steam and the stream of heated liquid is discharged at considerable velocity providing constant agitation.

Several other types of SK Steam Jet Heaters—for both tank and pipe-line heating—are shown at left. Complete details on all types are contained in Bulletin 3A which is available on request.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin G-1.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS SINCE 1876
2217 State Road, Cornwells Heights, Bucks County, Pa.

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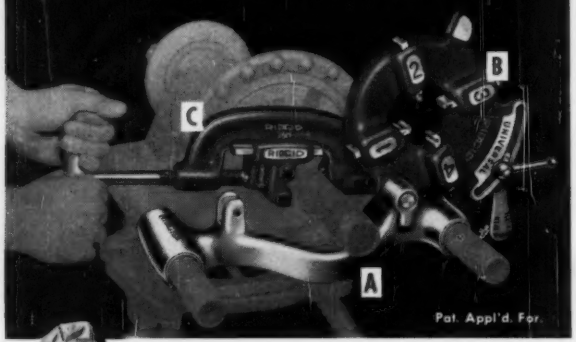
Now!... Convert Your

RIDGID

300 Power Drive

to a Fast, Smooth, Low-Cost

Threading Machine



"3 Efficient, New RIDGID Accessories Save Me Time on Every Job!"

A RIDGID No. 310 Carriage — Slip this strong, lightweight aluminum alloy carriage on the support arms of your RIDGID 300 Power Drive, and you'll get real cut-and-thread efficiency! Holds die head and cutter at your fingertips exactly like a pipe machine. No fumbling for right size threader . . . no tools to drop. Easy sliding . . . snugs right up to chuck for close threading and cut-off.

B RIDGID Die Heads — The time-saving RIDGID 535 Quick-Opening Die Head shown here, or any other RIDGID Machine Pipe and Bolt Die Head, snap-locks into carriage quickly, easily . . . eliminates slow back-off. Single adjustment on carriage centers die head exactly for true threads every time.

C RIDGID No. 360 Cutter — Full-floating, wheel-type cutter . . . wide rolls for straight cuts at pipe machine speed. Attaches easily with swivel drive pin. Fits 310 carriage only.

Die head and cutter operate independently . . . swing up and stay out of way when not in use. Add a RIDGID No. 19 Nipple Chuck and you can even thread close nipples.

For a bargain in fast, easy work, equip your RIDGID 300 Power Drive with these accessories that are available individually . . . at your Supply House!

RIDGID

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over multiple source buying of YOUR laboratory needs

Make Curtin your one reliable source for laboratory supplies. Complete stocks of quality laboratory equipment are maintained for immediate delivery at supply points strategically located in all major refining areas. Technical and Repair Services are readily available all the time to help with your specific problems. Call Curtin on your next laboratory order and get "everything at one source."

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Established 1922 U.S.A.

LINDE packaged oxygen plant sets nine-year record for availability!

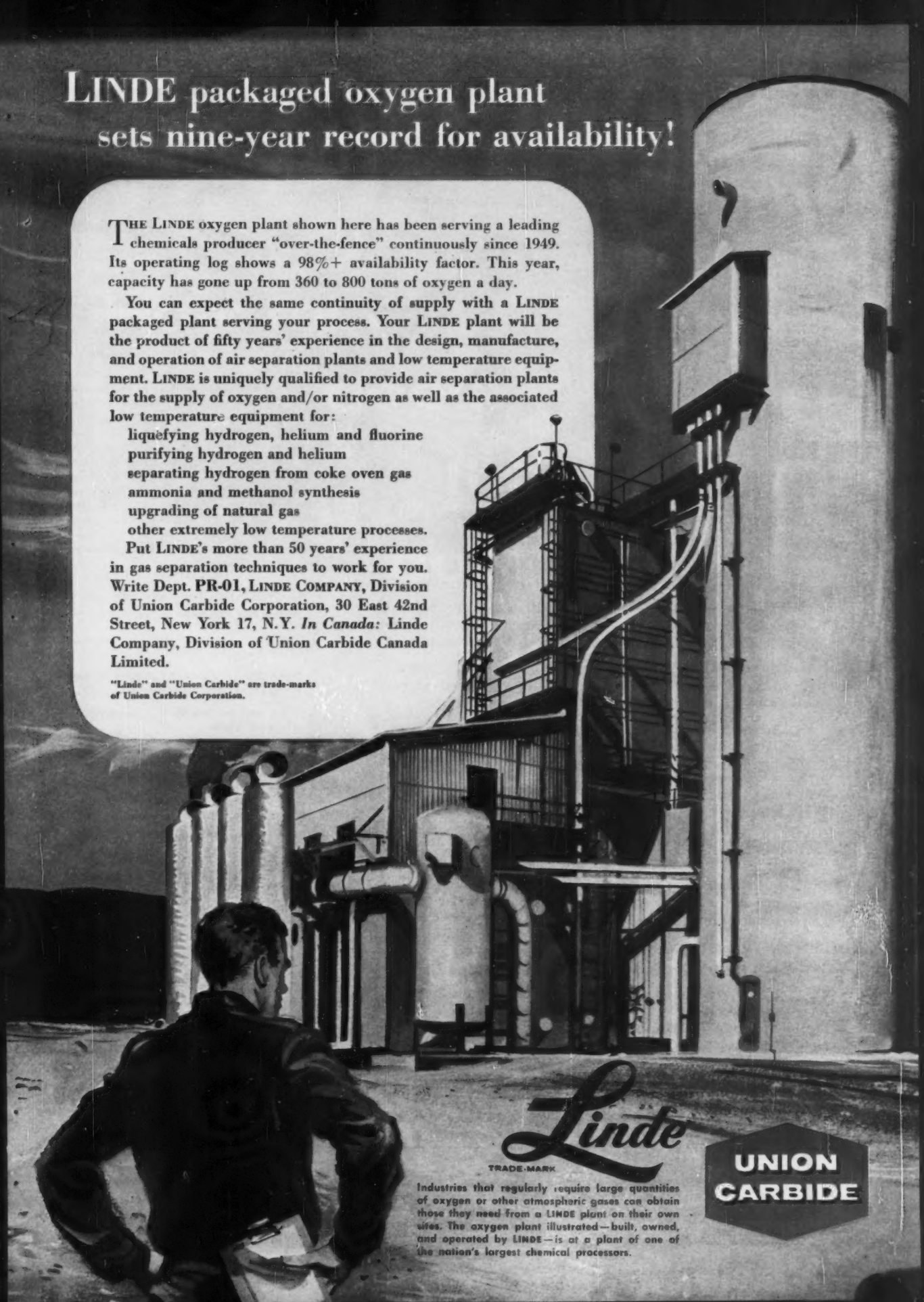
THE LINDE oxygen plant shown here has been serving a leading chemicals producer "over-the-fence" continuously since 1949. Its operating log shows a 98%+ availability factor. This year, capacity has gone up from 360 to 800 tons of oxygen a day.

You can expect the same continuity of supply with a LINDE packaged plant serving your process. Your LINDE plant will be the product of fifty years' experience in the design, manufacture, and operation of air separation plants and low temperature equipment. LINDE is uniquely qualified to provide air separation plants for the supply of oxygen and/or nitrogen as well as the associated low temperature equipment for:

liquefying hydrogen, helium and fluorine
purifying hydrogen and helium
separating hydrogen from coke oven gas
ammonia and methanol synthesis
upgrading of natural gas
other extremely low temperature processes.

Put LINDE's more than 50 years' experience in gas separation techniques to work for you. Write Dept. **PR-01**, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

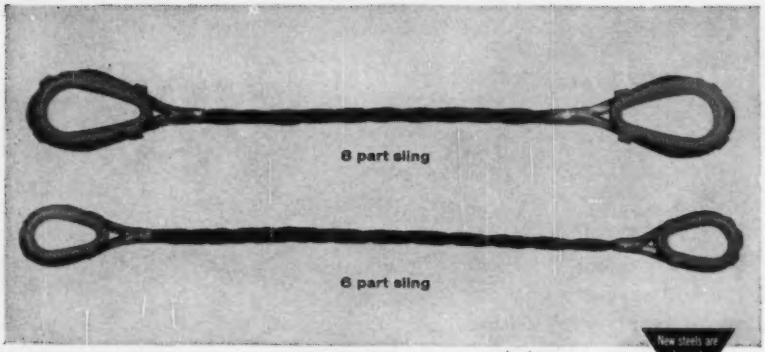
"Linde" and "Union Carbide" are trade-marks of Union Carbide Corporation.



Linde
TRADE-MARK

UNION CARBIDE

Industries that regularly require large quantities of oxygen or other atmospheric gases can obtain those they need from a LINDE plant on their own sites. The oxygen plant illustrated—built, owned, and operated by LINDE—is at a plant of one of the nation's largest chemical processors.



Now Tuffy covers all the bases...

NEW HAND-BRAIDED SLINGS

are added to the UNION line

Union Wire Rope Corporation, makers of famous Tuffy patented, 9 part, machine-braided slings, now bring you top quality hand-braided slings. Meet the new members of the Tuffy team:

The hand-braided 6-part sling provides wide bearing area; greatest single-plane flexibility; least strength loss under severe bending; high cutting and twisting resistance.

The hand-braided 8-part sling provides extra wide bearing area, gives extra flexibility in all planes, low strength loss in bending, highest resistance to kinking and spinning.

Like the entire line of Tuffy slings and hoist lines, these new slings are the product of extensive field and laboratory research. They're specially designed for extra strength and flexibility. Tight end-braiding keeps component parts equal in length so that each rope carries its full share of the load.

In these new slings you'll get quality backed by Union Wire Rope experience and integrity. And you'll get a bigger dollar valve in longer service life with greater safety.

Your Tuffy Distributor Will Help You Save Money on Every Sling and Wire Rope Use

He's the man to see when you're replacing or adding slings, hoist lines and wire rope. He is set up for fast service, backed by his nearby Union Wire Rope branch office and warehouse staff and factory engineers. Get in touch with him.

Tuffy Tips —on safe use of Slings and Hoist Lines

Professional Weight Lifters Work the Safety Angles

Here's a tip that could save an injury and absenteeism. The weight lifter's secret is proper leverage. Plus use of major leg muscles instead of back muscles. He never leans over to pick up the load. He squats down as near as possible to it. Lifting action comes from legs and thighs. If your workers must use muscles for some of the lighter lifting jobs, these points are worth remembering. But wherever possible—and always for heavy loads—use hoists and slings.

More Tips for Reducing Materials Handling Accidents

1. Teach your workers rated load factors. Warn them not to overload slings.
2. Use the right size hoist for every heavy lifting job. Don't put the load on muscles.
3. Show workers how to rig hoists properly and safely.
4. Inspect hoist load brakes often. Slipping or dragging brakes are a hazard.
5. Be sure to use the proper sling for the job. Don't assume that all slings made of wire rope are right for all lifting jobs.

FREE!
New Tuffy Sling Handbook

All about slings from A to Z, including types, dimensions and rated loads. Address **Union Wire Rope Corporation, 2284 Manchester Ave., Kansas City 26, Missouri.** Specialists in high carbon wire, wire rope, braided wire fabric, and stress relieved wire and strand.

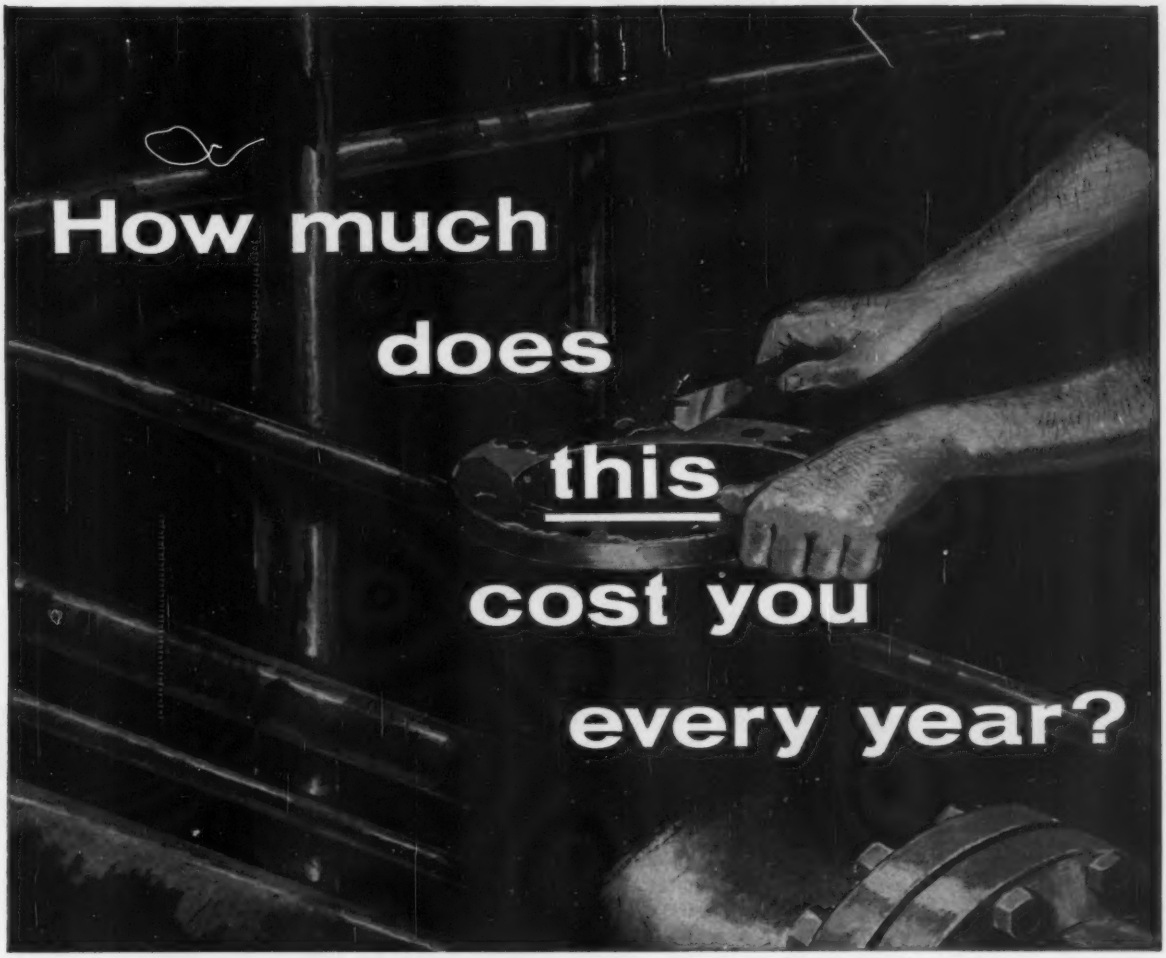
UNION Wire Rope

Subsidiary of ARMCO STEEL CORPORATION

OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company
Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Southwest Steel Products

For more data on advertised products, use Readers' Service Cards, last page.

Maintenance Cost Too High?



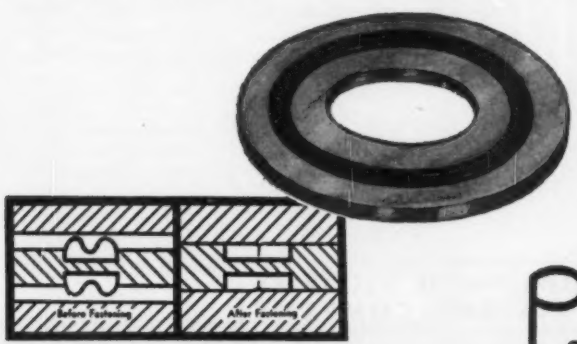
How much time, effort, and money is spent cleaning, resurfacing and/or replacing flanges to replace the seal!

Expensive? Yes!

Why not find out about Gask-O-Seals and save! Here are the facts: With Gask-O-Seal, flange faces require little or no cleaning or resurfacing of flanges when replacing the seal — *and Gask-O-Seals are re-usable.*

Gask-O-Seals save money and effort in many other ways, too. They are visually inspectable, do not need to be re-torqued, there is no material creep and they are non-directional, non-flexible, easy to install. They provide no-leakage sealing, *can not blow out,* and there is no wear due to pulse.

Now available to fit ASA standard flanges. Write for free catalog.



Note metal to metal contact.

Parker SEAL COMPANY

CULVER CITY, CALIFORNIA and CLEVELAND, OHIO

A DIVISION OF PARKER-HANNIFIN CORPORATION

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From the SIMPLE...

"Varec"

LOW WIRE COUNT

•

DOUBLE CONTACT TELEPHONE TYPE RELAYS

•

BUILDING BLOCK DESIGN

•

NO PRIMARY POWER NECESSARY AT TANK

•

FIELD TESTED COMPONENTS AND SYSTEMS

•

10 TO 1000 POINT SELECTION

LOCAL TYPE SYSTEM:
(DIRECT WIRED SYSTEM)

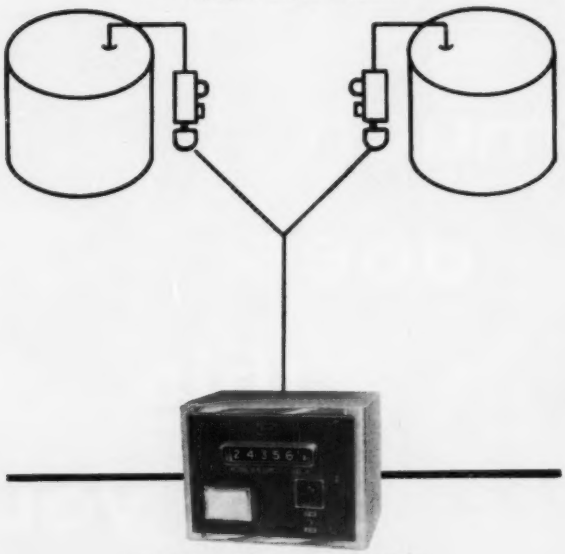


FIG. 9310 SERIES RECEIVER

"Varec"

PRINTED CIRCUITS

•

INHERENT PARITY CHECK

•

CODED PULSES

•

TRUE REMOTE OPERATION CHECKING

•

SPOT OR AVERAGING TEMPERATURE COMPATIBLE WITH ONE FIELD UNIT (NO DUPLICATION OF EQUIPMENT)

•

JET SPEED — ANSWERS • 5 SECONDS

to the COMPLEX...

One or hundreds of tanks. One measurement or many. Control function and alarm signals. A few feet or hundreds of miles. Direct wire, low grade communication pair, tone or microwave. Manual selection or programmed scanning with automatic lockout. Digital readout. Transceiver output suitable for entry into almost any conceivable type of digital data processing equipment.

That's "Varec's" Pulse Code Telemetering* System designed specifically for the petroleum and petro-chemical industries to remotely indicate measurements and alarm conditions and to perform supervisory control functions.

Simplicity of application is matched by simplicity of instrumentation. Complexity of application is matched not by complex instrumentation, but by combining production line "building block" units in an arrangement commeasurable with requirements.

A complete "Varec" Pulse Code Automation System can handle with a single or multiple receiver installation the following:

Liquid Level, Flow (P.D.M.) Volume, Temperature, Pressure, Valve Control, Pump Control, Supervisory Data Gathering and Reduction.

For complete information on "Varec" Pulse Code Systems, we invite you to contact your nearest "Varec" representative, or send for New Bulletin CP — 3707.

* Patents Pending
U.S.A., Great Britain, Japan
Patented
France, Pat. No. 1,163,861

"Varec"
TRADE ® MARK

THE VAPOR RECOVERY SYSTEMS COMPANY

P-7

"VAREC", 2820 NORTH ALAMEDA STREET, COMPTON, CALIFORNIA. *Branches and Representatives in Principal Cities.*

"Varec" PROVEN–ADVANCED DESIGN... PULSE CODE

COMPLETE AUTOMATION SYSTEM

LIQUID LEVEL • P.D. METERS • TEMPERATURE • PRESSURE
VALVE CONTROL • PUMP CONTROL • SUPERVISORY
DATA GATHERING AND REDUCTION SYSTEM

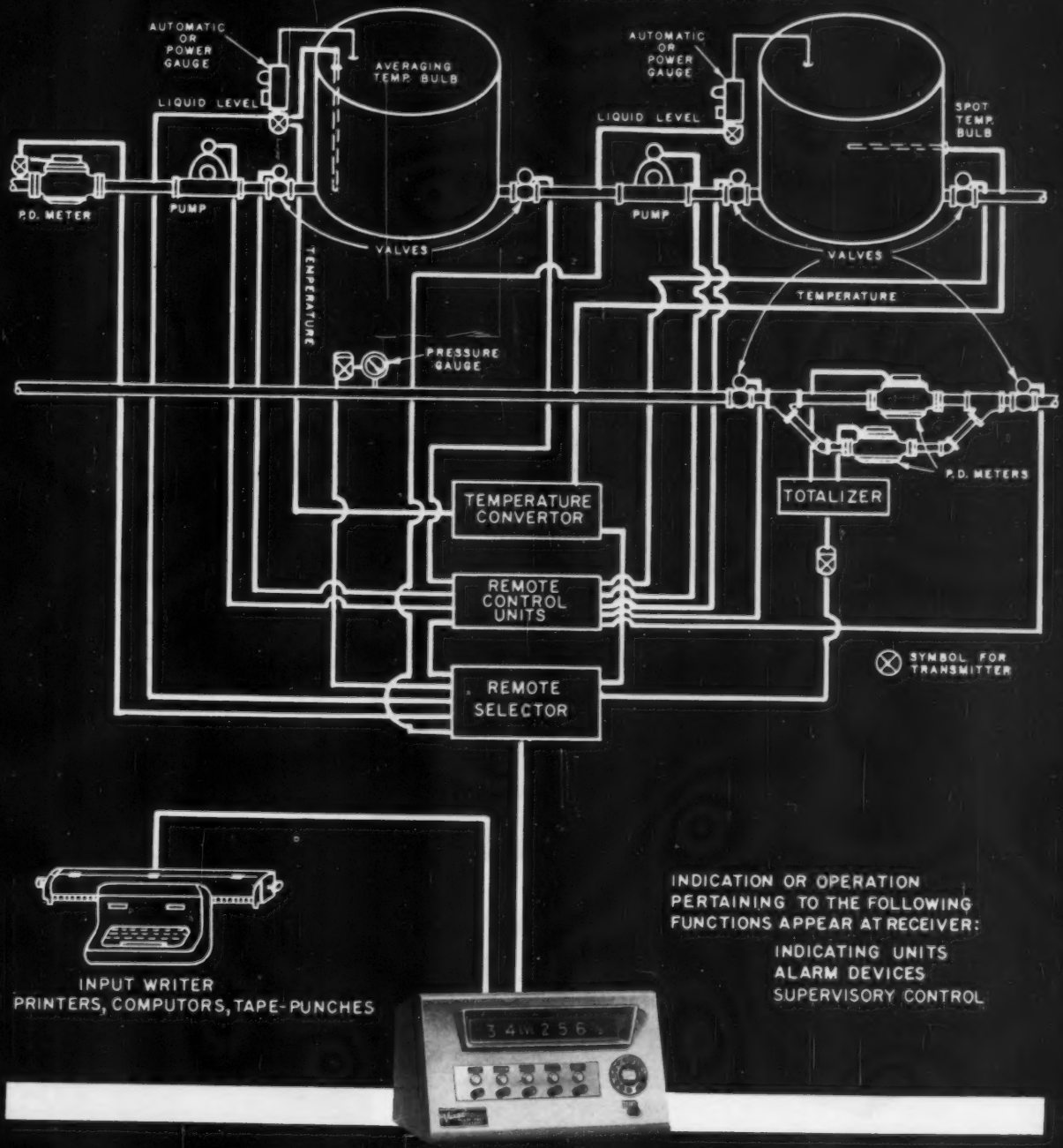
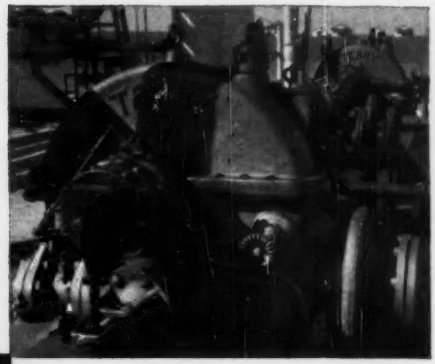
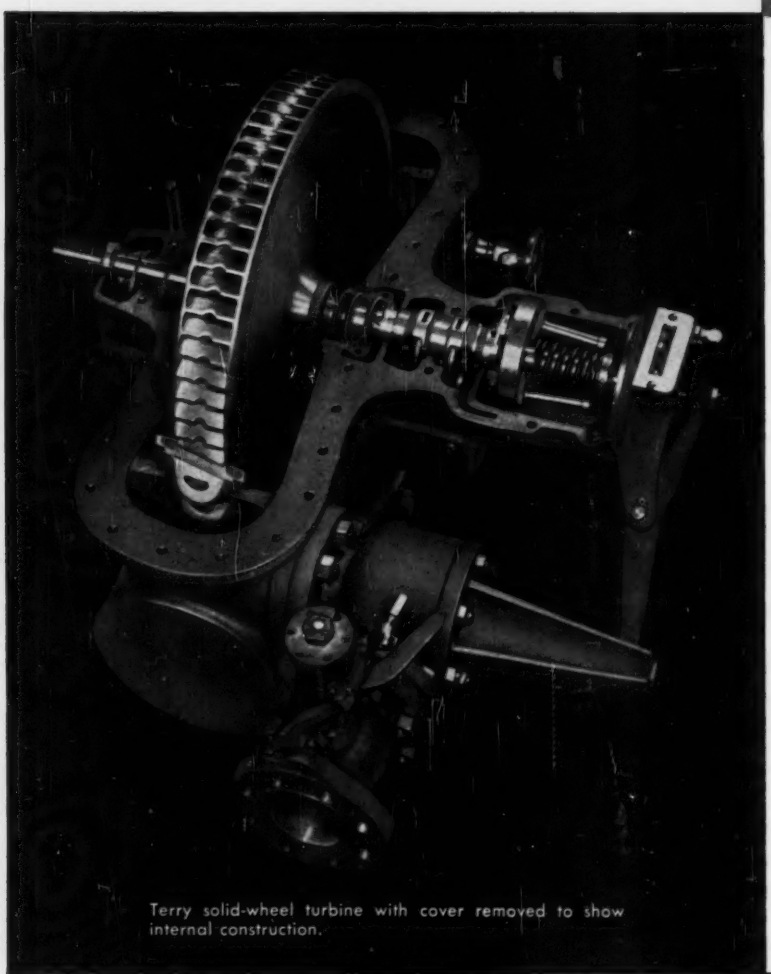


FIG. 9346 SERIES RECEIVER

TERRY SOLID-WHEEL TURBINE

spells service continuity for mechanical drives





Terry solid-wheel turbine with cover removed to show internal construction.

For mechanical-drive applications, such as these, you will never find the equal of Terry solid-wheel turbines for built-in dependability. They are *designed* for trouble-free operation under the toughest service requirements.

The wheel, for example, is a single forging of special composition steel. Unlike a built-up wheel, there are no separate parts to loosen or work out. The blades can't foul since they are double-rim protected...with one-inch clearances at either side.

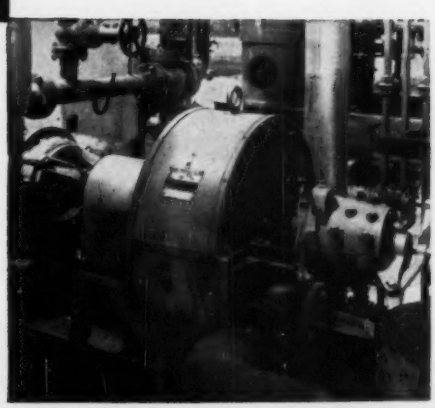
Any blade wear, which might occur after years of service, is of little consequence. As the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets, wear does not materially affect horsepower or efficiency.

Specify Terry solid-wheel turbines for your next mechanical drives. They are available in capacities from 5 to 2,000 hp., speeds up to 10,000 rpm. Vertical turbines are built in sizes from 5 to 300 hp.

For full information about these reliable turbines, send for bulletin S-116.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



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EXPERIENCE

is always on stream *with* AIR LIQUIDE

If you're planning to build a new plant — to extend — or to rebuild . . . tap this rich stream of low-temperature experience! If it's a question of gas separation or recovery, Air Liquide has the efficient, economical, proven answer.

The Air Liquide stream of experience has been flowing around the world for over half a century. Gaining year by year broader and accurate know-how, it has produced hundreds of low-temperature gas separation plants all over the globe.

Whether you need a plant from an existing design or one especially designed for your particular requirements, Air Liquide can supply it. From the initial technical consultations, design work, manufacturing of plant and equipment, to the expert erection and start-up supervision, our widely experienced Research, Design, and Project teams smoothly coordinate with yours.

We shall be pleased to consult with you in the application of Air Liquide processes and equipment to your particular needs. Write or call us at 405 Lexington Ave., New York 17, N. Y. Telephone: YUkon 6-6544.

AIR LIQUIDE HAVE DESIGNED AND BUILT THE FOLLOWING TYPES OF PLANTS

- Air Separation — oxygen, nitrogen, etc.
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- CO_2 Purification
- Methane Purification
- Natural Gas Liquefaction
- Coke-Oven Gas Separation
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- Hydrogen Liquefaction
- Helium Recovery
- Pure CO_2 Production
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AIR LIQUIDE
ENGINEERING & CONSTRUCTION DIVISION
OLDEST IN EXPERIENCE — NEWEST IN DESIGN

405 LEXINGTON AVE., NEW YORK 17, N.Y.

For more data on advertised products, use Readers' Service Cards, last page.

Trapping Standardization

. . . steam trap standardization plus standardized hook-ups spell lower maintenance costs

An important weapon in the fight against rising maintenance costs is standardization. It can reduce the variety of maintenance problems and simplify those which remain.

Since we specialize in steam traps we'd like to offer some suggestions for a trapping standardization program. Such a program involves standardization on one make of trap and standardization of hook-ups.

Trap Standardization

The advantages of standardizing on a single make of trap are important and can make a big difference in the cost and ease of repairs because—

1. You can carry a more complete stock of repair parts with a smaller inventory.

2. Maintenance personnel has the opportunity to become expert on one make rather than be "jacks of all traps."

3. As an exclusive user of one make of traps you become a preferred customer of your trap representative and can be sure of getting the best possible service.

4. You can enjoy the advantages of standardized hook-ups.

Standardized Hook-ups

Standardized hook-ups facilitate and reduce the cost of both original installation and maintenance. By adopting standards for the dimensions of all fittings, including nipples, each hook-up for a given size of trap is identical and can be fabricated in the pipe shop.

Unions should be used so that when a trap needs repair, the unions can be uncoupled, the trap lifted from the line and a spare carrying identical length nipples and half unions slipped into place. In as little as a minute or two a faulty trap can be replaced. The faulty trap can go back to the storeroom for repair when convenient and then be put into stock as a spare.

Figure 1 shows a typical standardized hook-up used by a major chemical manufacturer. Note how

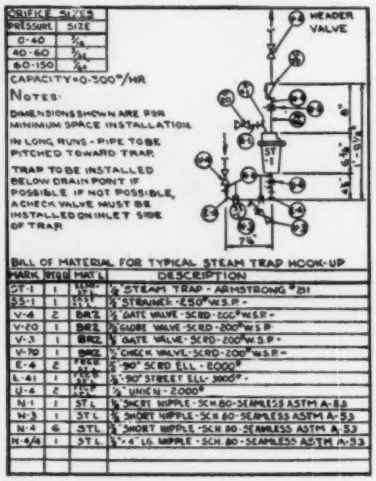


Fig. 1—Typical standardized installation hook-up used by a leading chemical manufacturer.

the hook-up provides the following advantages:

1. Test valve in trap cap permits fast, easy checking of trap operation.

2. Strainer ahead of trap protects it against dirt and scale.

3. Blowdown valve in strainer provides easy cleaning.

4. Check valve in discharge line isolates trap when test valve is opened.

5. Shut-off valves and unions ahead of and following trap permit removal of entire trap from line.

Fig. 2—Armstrong traps have only two moving parts—the lever assembly and the bucket. Nothing much to go wrong here.

Another important consideration for getting the most from a standardization program is accessibility of the traps. Insofar as is possible, traps should be located so that they are convenient for inspection. The easier it is to locate and get at a trap, the less likelihood that it will be overlooked.

What Make of Trap? (This is the Commercial)

Obviously, a trap standardization program shows the best results when the make of trap selected is the one that gives the best service. Naturally, we think the make should be Armstrong and fortunately a lot of trap users agree. Here are some of the advantages of standardizing on Armstrong that have been pointed out by these users:

1. *Armstrong traps work.* They don't leak steam and they do discharge condensate and air as fast as they reach the trap. And they work with any return system.

2. *Armstrong traps aren't "prima donnas."* They need no special care or coddling. Valve and seat are hardened chrome steel. Lever assembly and bucket are stainless steel and these are the only moving parts.

3. *Armstrong traps aren't "orphans."* You can *always* get parts and service from nearby Factory Representatives and stocking distributors.

4. *Armstrong traps are guaranteed.* If you're not *completely* satisfied you can return the traps for refund of purchase price.

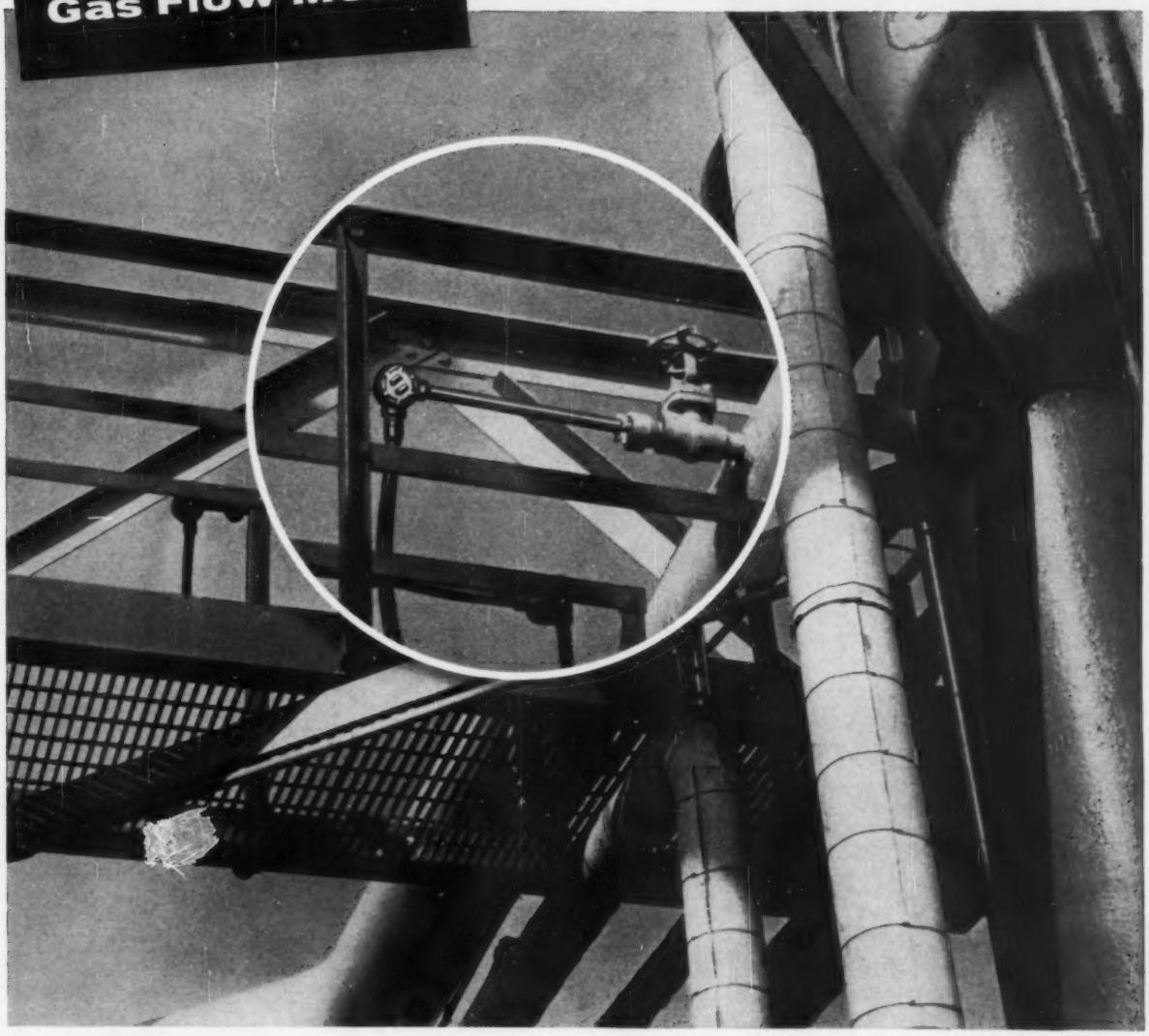
More Information

The 44-page Steam Trap Book (free on request) gives a lot more facts on trap selection and installation. Call your local Armstrong Representative or write **Armstrong Machine Works, 8521 Maple St., Three Rivers, Michigan.**

ARMSTRONG STEAM TRAPS

(See our catalog in Refinery Catalog)

"Anemotherm" Gas Flow Meter cuts flare stack losses



Are thousands of dollars going up your flare stack? You can substantially reduce these flaring losses with the "Anemotherm" *Probe-Type* Gas Flow Meter. This electronic, stainless steel instrument accurately measures the gas flow in the flare stack and the lines leading into it from various units. By determining flow rates and points of loss, refineries report savings of thousands of dollars per day.

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- *measuring the flow of air in catalytic cracking units*
- *metering the rate of flow in gas transmission lines.*

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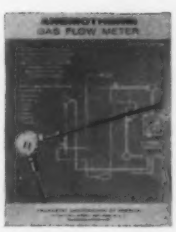

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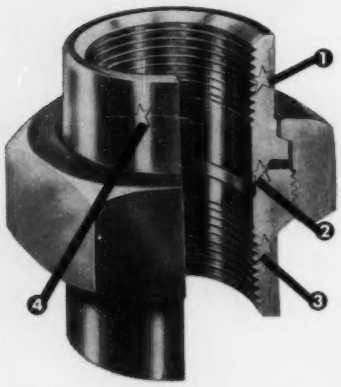

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The Mail Box...

Clip and Paste for Transposed Line

In the November Petrochemical Handbook, Vol. 38 (1959) No. 11, page 244 "Ethyl Alcohol—Shell Development Company" the table "Operating Conditions" had one line transposed. Readers are asked to please clip this correct table and paste it over the one in error:

Operating Conditions: The conditions for the ethylene hydration reaction are as follows:

Reaction temperature	570° F.
Reaction pressure	1000 psig.
Reactor feed ethylene concentration, water free basis	85 percent
Ethylene make-up concentration	97 percent
Water-to-ethylene molal ratio in feed	0.6
Space velocity, VSVM	30
Ethylene conversion per pass	4.2 percent
Water conversion	7.0 percent

Service to College

To the Editor:

Professor Jay R. Gould, director of our Technical Writers' Institute, has told me that once again you have, most thoughtfully, sent him a large number of copies of your Author's Handbook.

I very much wish to tell you how appreciative we are of these gifts and how much this does help us, especially in connection with the Technical Writers' Institute. I am sure you are aware of the difficulties which all educational institutions experience in obtaining materials and aid of various kinds. We certainly are no exception. Your consideration, therefore, is appreciated sincerely. Allow me to thank you again.

Ronald A. Mueller
Office of the Dean of Social Sciences
Rensselaer Institute
Troy, N. Y.

Misconceptions?

To The Editor:

Although I agree with much that was said about the maintenance of reciprocating pumps in Part 5—Reciprocating Pumps of the Operator's Handbook for Gasoline Plants Page 307, November 1959, PETROLEUM REFINER, I think that some common misconceptions about packing were expressed.

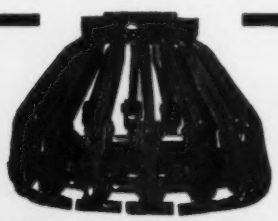
Contrary to what seems to be a general belief, V-type packings are not self-sealing. But, perhaps I should qualify this statement somewhat. At low pressures and, as long as some resilience remains in the lip of the packing, there will be a sealing effect until a little wear takes place. When this happens, there is then a balanced pressure across the lip and leakage will occur unless the packing is tightened. Under pressures of several thousand pounds, unless the fluid is oil, water or something with lubricating properties, the lip resilience and self-sealing action disappear very quickly. The V packing is then no different than square packing.

There is an answer to problems of this nature. In an article by me which you published early this year I described a spring loaded packing which has been very successful in difficult services. The same principles govern both reciprocating rods and rotating shafts and it is just a question as to how the packing is applied to them. Using the spring loaded principle, both square and V packings have been used with excellent results on reciprocating plungers for pressures to 20,000 psi with a non-lubricating liquid. But, as a word of warning, the spring application must be made properly and it is not made in the same way for reciprocating rods as for rotating shafts.

Walter Coopey
Engineering Consultant
Charleston, W. Va.

What Do You Think?

The Editors of PETROLEUM REFINER invite letters from readers discussing topics pertinent to the industry



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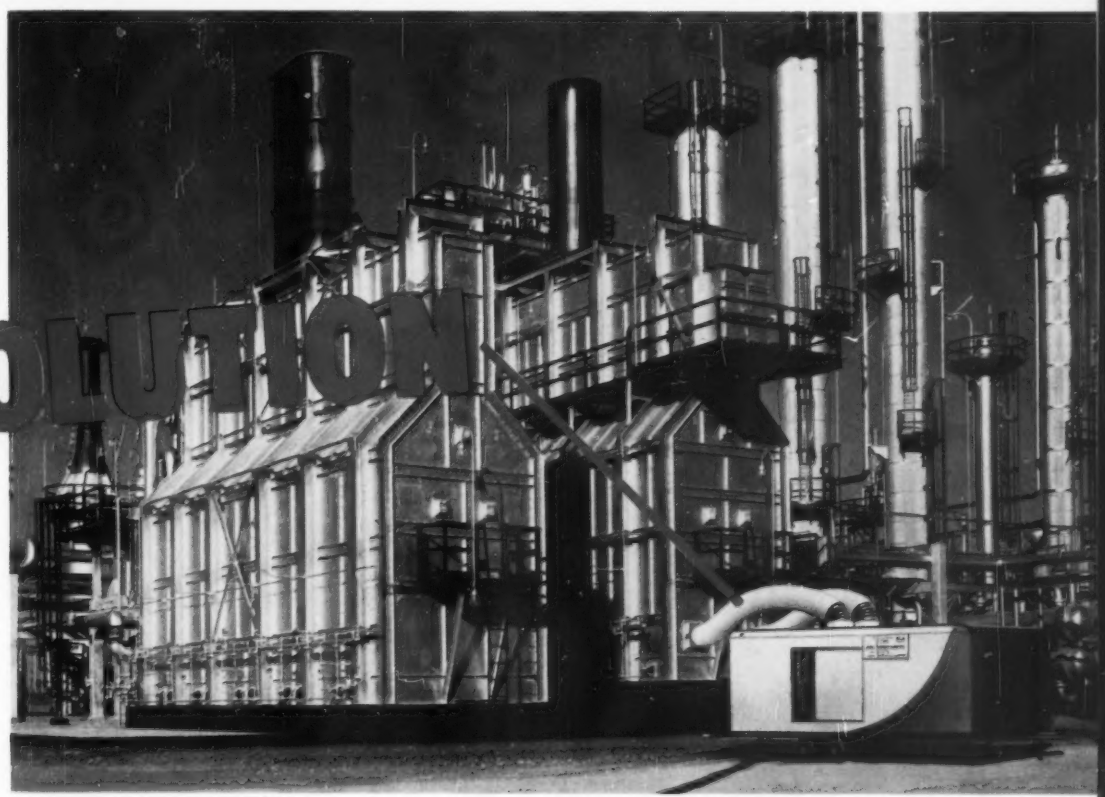
A PETROLEUM REFINER SPECIAL REPORT

MAINTENANCE SUPERVISOR'S HANDBOOK page 115



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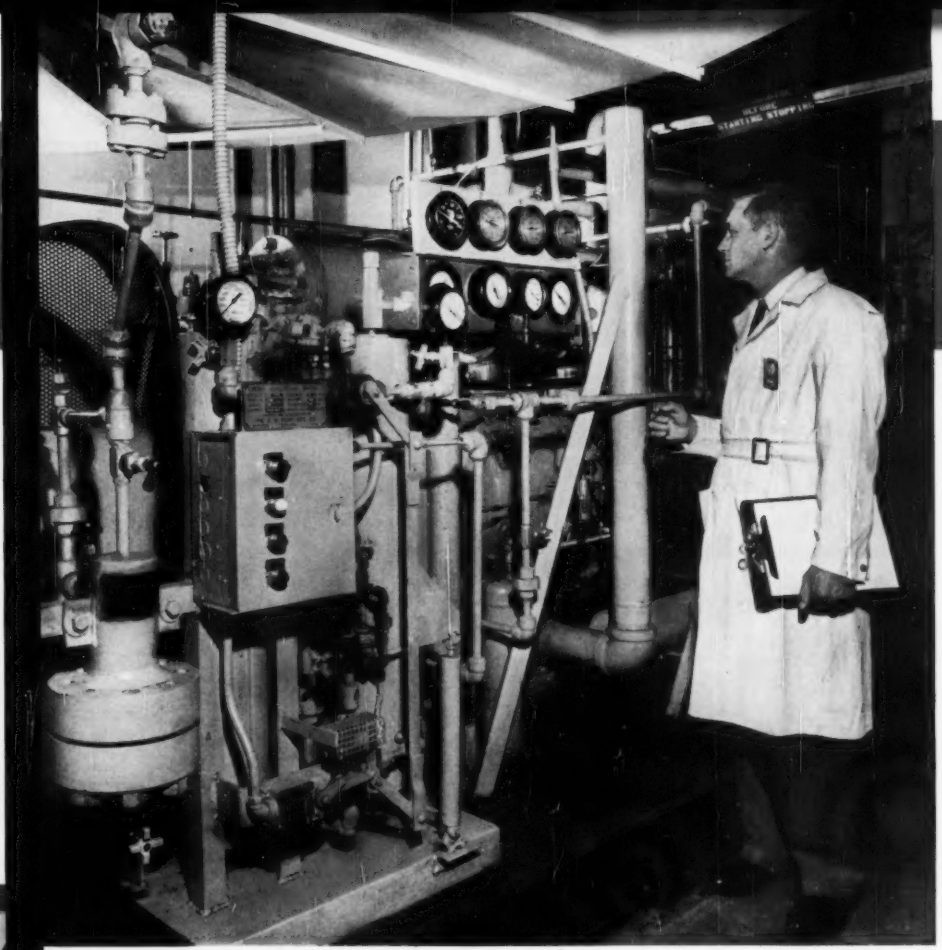
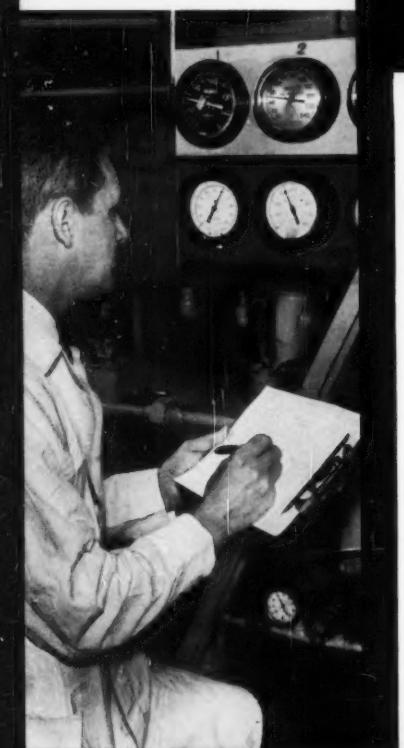


Right
Four-stage air compressor in operation at Hamilton Standard Division of United Aircraft, Windsor Locks, Connecticut. Fire resistant Celanese Cellulubes materially reduced downtime and maintenance costs.

Below
Mr. Robert Fredrickson, Foreman, checks compressor operation.



Air cost extra thousands...

until Hamilton Standard switched to Cellulubes

At Hamilton Standard, lubrication of a 4200 psi four-stage compressor was a serious problem. Carbon deposits from petroleum lubricants made it necessary to lease a stand-by compressor, and a mechanic was assigned to round-the-clock duty to prevent valve malfunction and spring breakage. Even so, repair bills and maintenance costs ran into large sums of money, and valuable production time was lost. After switching to Cellulube 220, only routine maintenance was required. The formation of petroleum carbon residues ceased, and oil fouling of the compressed air dryer was eliminated. The former constant threat of fire and explosion was also eliminated. Cellulubes made it possible to ship back the stand-by compressor and turn over servicing of the machine to its regular department.

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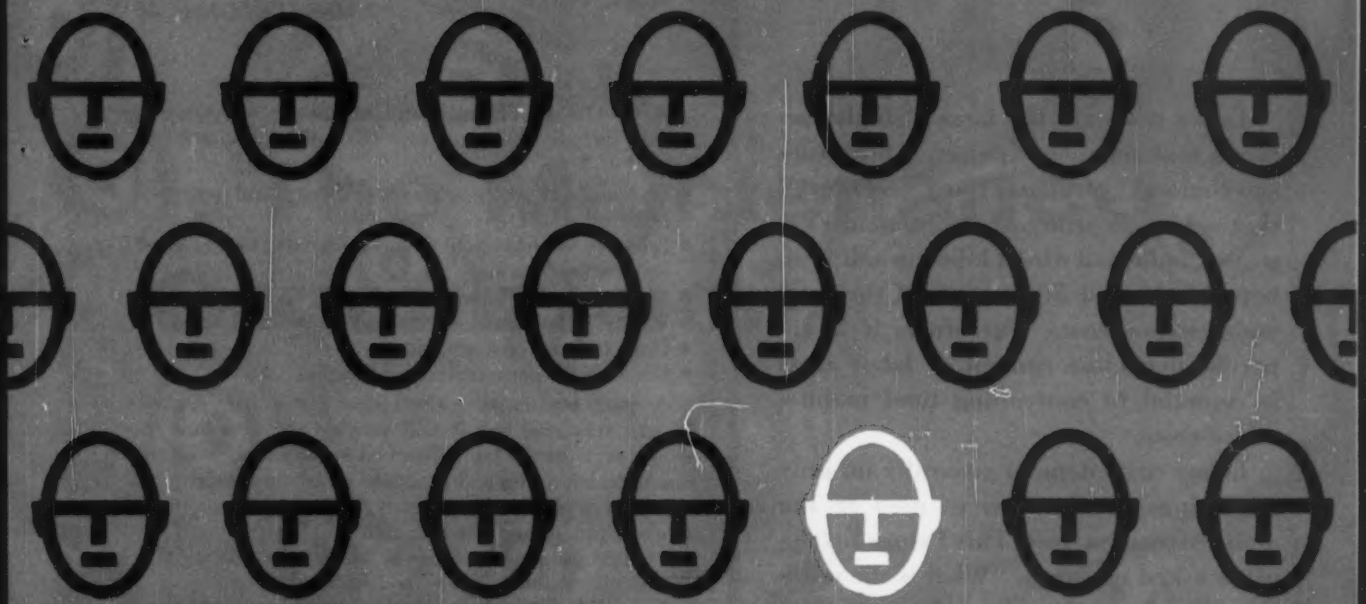
A PETROLEUM REFINER SPECIAL REPORT



MAINTENANCE SUPERVISOR'S HANDBOOK

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5. Keeping Cost Records 141
6. Turnarounds 147
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Labor costs are the largest single factor in maintenance expense. A few years ago General Petroleum Corp. announced that a 15-year study of maintenance expenses indicated direct labor usually ran between 40 and 50 percent of the total maintenance costs. Therefore, it is apparent that close control of labor costs is essential in controlling total maintenance costs.

Labor costs depend generally on only one thing—the number of men on the maintenance payroll. This brings up the often asked question, "What is the minimum size force that can maintain a plant satisfactorily?" A crew that is larger than necessary can be wasteful but a crew that is too small can cause excessive unit downtime and poor onstream efficiencies because of fouled and dirty equipment.

Some refiners say that peak manpower demands determine the minimum basic crew. This peak demand is usually determined by the number of weeks of major unit turnarounds per year. For a starting point, look at the number of men required to complete a major unit turnaround in five days plus the minimum necessary running and standby maintenance work at the same time, keeping in mind that some crafts, like painters, are independent of shutdown work but do add to the total work load.

Generally, this is what the handbook is all about—managing the Maintenance Department to get the most out of your labor force.

A good maintenance supervisor has often been defined as not necessarily the best craftsman but the man who can manage his crews efficiently. Check on your methods by reviewing other plants' practices, starting with your organization.

A GOOD REFINERY maintenance organization should include in its structure the following characteristics:[1]

- Well-defined assignment of authority and responsibility
- Effective coordination (men, materials, tools), good communications
- Standardization of methods
- Workable preventive maintenance programs
- Craft training of mechanics
- Good sound personnel administration.

A good organization alone may not achieve good human relations, but it will provide the structure on which they can be built. By good organization is meant one in which duties and functions clearly are understood and lines of responsibility clearly drawn with a minimum of overlapping; one in which staff and line functions are segregated properly; and one in which responsibility and the necessary authority go hand in hand.[2]

In considering what it takes to have a good organization, the various types must be reviewed. Most petroleum processing plants today use the area system or a combination of the area and centralized system. There was a time when everyone used a centralized system. It is still used in some of the smaller plants, but expansion and large work areas imposed more disadvantages on the centralized system than advantages. Take a look at these systems and see for yourself which may be best for your plant.

Centralized Maintenance. The best definition of centralized maintenance is one word—"pool."[3] The pool is set up so that manpower can be drawn from it to take care of regular maintenance work or for emergency repair. The pool is usually located in a central part of a plant or as near as possible to it so that travel time can be minimized.

Craft System. The craft system is a form of centralized maintenance and the most popular of the non-area systems in use today. Standard of Indiana's Casper, Wyo., refinery (17,000 bpd crude charge) recently discarded this system.[4]

They used five separate craft departments headed by a general foreman. In addition, they had a Planning Department and a Stores Department reporting to the mechanical superintendent.

The reason Standard discarded the system was inadequate job and manpower control. Authority and responsibility for work was not clearly defined and there was not sufficient information for accurate analysis of results.

Disadvantages of Centralized Maintenance. Considable travel time is required in a large and diversified process plant because manpower assignments require moving from one job to another over a wide area. In other words, the chief disadvantages are difficulties with communications and manpower movements.[5]

A central tool room is obviously a serious bottleneck because of the travel time required.

Maintenance mechanics and foremen who travel from

1. The Maintenance Organization

Frank L. Evans, Jr., Maintenance and Design Editor
PETROLEUM REFINER

unit to unit are often uncertain on safety procedures and work methods desired because different units have different processes and equipment.

The craft foremen and men are scheduled to work in one area one day and another area the next day; consequently, a sense of responsibility for maintenance on any particular group of equipment is not acquired. A maintenance mechanic may repair a piece of equipment when it breaks down, but another mechanic will probably be scheduled to repair the equipment at a later date. Therefore, familiarity with each piece of equipment is not obtained.

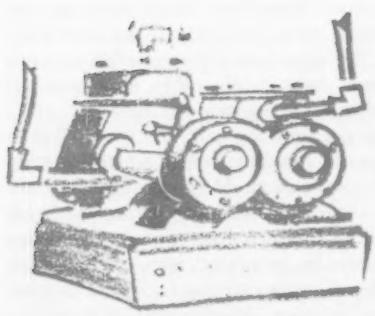
Area Maintenance System. This system is simply the division of the plant into areas, each having its own maintenance crews. The reason this system operates so well in process plants is that the Maintenance Department has a parallel organization with the Operations Department. In other words, communication is probably the key word to the success of area maintenance in refineries and petrochemical plants.

This system is used by Esso, Bayway and many other mechanical departments. The three main functions of the Esso system are:[6]

- Planning
- Job execution
- Administration of personnel and upgrading of craft skill.

Under the Esso system, the Maintenance Division is divided into four geographic control centers, or regions. Each of these centers contain similar processes. For example, Region 1 contains the atmospheric distillation units, other refinery units, steam, power and other utilities for the refinery. Region 2 contains the thermal and catalytic cracking units, catalytic conversion processes and high pressure light ends operation. Region 3 contains the chemical products operation and Region 4 contains the oil movement and storage operations.

Each geographic region is further subdivided into zones and areas to conform, as nearly as practical, to process areas of responsibility. In other words, the first line process supervisor and the first line maintenance

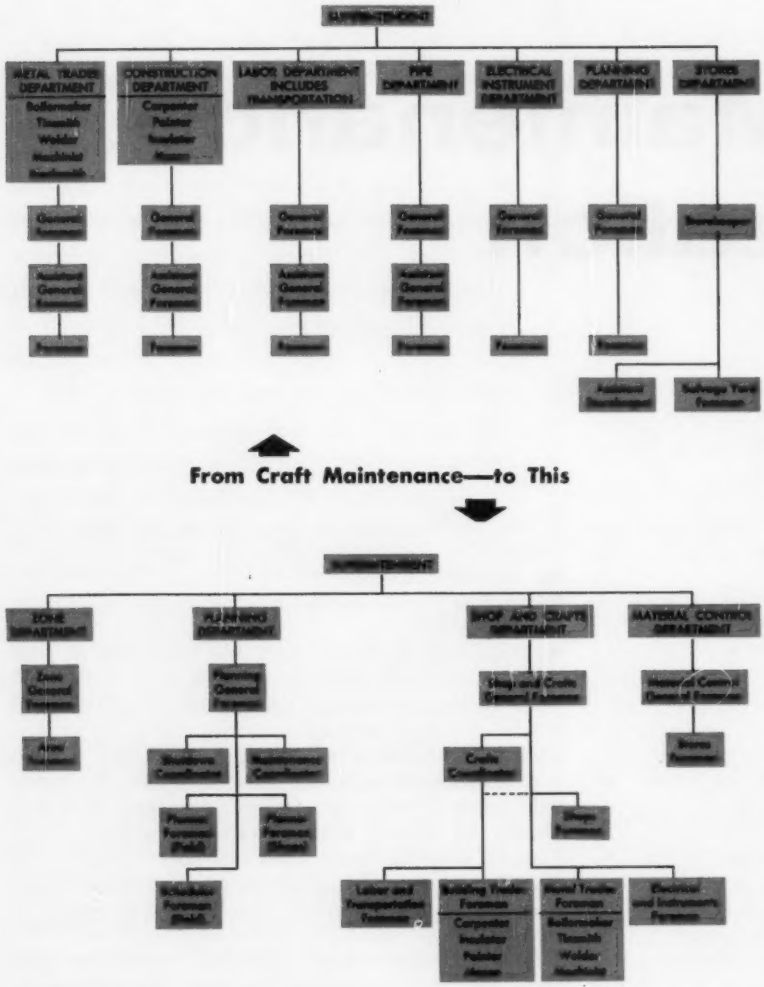


Is your organization set up to remove a faulty pump--*efficiently?*

Sequence . . .

1. Electricians (Pull switch)
2. Carpenters (Shore lines)
3. Insulators (Remove insulations)
4. Machinists (Uncouple pump—Loosen anchor bolts)
5. Pipefitters (Break lines and blank off)
6. Riggers (Remove pump)
7. Transportation (Deliver to shop)

Seven trades...Seven contracts



From Craft Maintenance—to This

Standard of Indiana's Casper, Wyoming refinery remodeled its old craft system into a modern area system.

supervisors are responsible for roughly the same area. Therefore, the communications between these departments are very good since there can be an immediate understanding of any problem right at the unit.

Advantages of Area Maintenance. When operating and maintenance personnel work together every day they become acquainted with each other and each other's method of work. Thus they perform well together as a team.

The continued repair of the same equipment over a long period of time permits area maintenance personnel to become fairly familiar with the equipment. Improved methods and procedures of repair are learned. Shortcuts are developed through increased skill which enables the personnel to do a faster and higher quality repair job.

Tool rooms are usually located in each area for the use of the maintenance personnel within that area. Small material parts are stored in the tool rooms to reduce time required to obtain such parts. These parts are only those frequently used such as bolts, nuts, gaskets, nipples, fittings, etc.

Supervisory responsibility can be pinpointed because of complete job supervision under one supervisor.[4] Closer supervision and more contact with the men, better coordination between operating and mechanical supervision on maintenance work, better control of material, and better planning and scheduling are all possible. Personnel problems and the need for craft improvement training for certain craftsmen are pinpointed and should result in improved solutions at a minimum cost. Improved morale and job interest of supervisors can be seen. Operator participation in job planning and scheduling is more active because of strict adherence to job priority system. Improved individual job cost reporting to operators improves cost consciousness. More time is spent on the job in fieldwork because craftsmen report to area headquarters at the beginning of each shift.

Disadvantages of Area Maintenance. One of the problems most quoted by people who do not believe in the area maintenance program is that the area supervisor begins to feel that his area is the most important in the organization.[5] In a number of cases, it was found that areas were operating practically as independent businesses and were, in fact, in competition with the other areas for personnel, materials and job priorities.

Critics point out that in a true area system, unusually large plant inventories are carried because of duplication throughout the areas.

Another problem is that under an emergency or shutdown, mechanics drawn from their home area are unfamiliar with personnel and equipment in another area. In many instances, the area men are compelled to work overtime, at overtime rates, while other areas not affected are waiting for an emergency to arise.

Area foremen are not familiar with the work of each craft and are frequently handicapped in supervising individual items of job execution. Most organizations are set up to provide technical assistance from the craft foreman, however area foremen hesitate to avail themselves of this assistance or, in many cases, cannot work it into their schedules. Special training for the area foreman seems to be the solution. Mechanics feel that they have lost their craft home and miss the guidance and advice of more-or-less permanent craft foremen. Crafts-

men may work under several different supervisors in any one week and may also work in several different parts of the plant. If they have a question about their craft, they tend to go to the craft foreman instead of consulting their area supervisor.

Combination Central and Area Maintenance System. Phillips Chemical uses this system at its Adams Terminal, Pasadena, Texas, plant.[5] Their Shops Group works along the general lines of a centralized maintenance organization. Their functions are:

- To maintain general utilities serving all plants, such as roads, electric power, gas, water and raw product lines
- To operate skilled shops for major overhauls, and fabrication of equipment
- To dispatch, operate and maintain the mobile equipment
- To paint and insulate
- Carpentry and masonry work
- To provide maintenance personnel and supervision for shift maintenance work
- To supply additional workers to zones as demanded by the work load.

The Phillips' plant is divided into two zones which are, in turn, divided into areas under the direction of area foremen. The foremen are assigned to a certain area or unit and are really job or multicraft foremen because they have complete responsibility for maintenance work in their area.

Changing From Craft to Area System. The first job required for changing from a craft or centralized system to an area system is the preparation of detailed procedure manuals which give the organizational concept and provide detailed descriptions of procedures to be followed, job descriptions outlining duties and responsibilities of all supervisory and clerical assignments, as well as the necessary forms required for operation of the new system. Office space must be provided for each area supervisor and special area tools such as a radio call system, necessary office furniture, printing equipment, etc.

The next step is to provide a good educational program for both supervisors and the maintenance staff. This requires a number of hour to hour-and-a-half meetings detailing the organizational plan.

A small plant may be divided into two zones headed by a zone superintendent. Each zone is then divided into smaller maintenance areas in which case each area is supervised by an area foreman or area superintendent.

In a small plant, the area foreman is responsible for obtaining material and for keeping the time of the craftsmen working in his area.

At Standard of Indiana's Casper refinery, the shop foreman is also responsible for what they call "functional work," which consists of special machinery overhauls, yard clean-up and janitorial services.[4] However, when they are in an area, they may work under the direction of the area superintendent.

Under the Standard plan at Casper, the Shops Department is also responsible for assignment of all personnel to maintenace areas in the plant as well as craft training. They do not perform planning and scheduling because this is done by a Planning Department.

How Esso Formed an Area System. Early in 1953, Esso Standard Oil Company's Bayway refinery decided that their Field Coordination Section was obsolete.[1] This section coordinated the daily mechanical work, planned weekly manpower assignments, and developed better work techniques and preventive maintenance programs. Originally the section was fairly closely aligned with the process organization. However, a rapid increase in the size and complexity of the process operations, without a corresponding increase in the Field Coordination Section, resulted in the loss of a direct line relationship between the Mechanical Crafts Section and the Field Coordination Section. This presented a difficult problem in obtaining all of the organization's maintenance objectives.

The first step to correct this deficiency was to divide the plant into physical areas which would be in close alignment with the process organization. Consideration was given to

- The physical size of the area
- The complexity of the equipment within the area
- The number of mechanics required for routine maintenance in the area.

The second step was to establish the new position of area supervisor for each individual area. His counterpart in the process operation is the process supervisor and his duty was to coordinate mechanical work within his area, with full authority to give work assignments to mechanics of all crafts working in his area on routine maintenance.

A new position of zone engineer was established and craft foremen were relieved of the time-consuming responsibility of assigning manpower to jobs, job pushing and, in general, maintaining all process equipment in good operating condition. A survey of the craft foreman's activities indicated that 16 percent of each foreman's activities would be transferred to the new area supervisor. This meant that the craft foreman could supervise a larger group of mechanics and devote more time to the primary responsibility of work direction, craft training, and personnel administration.

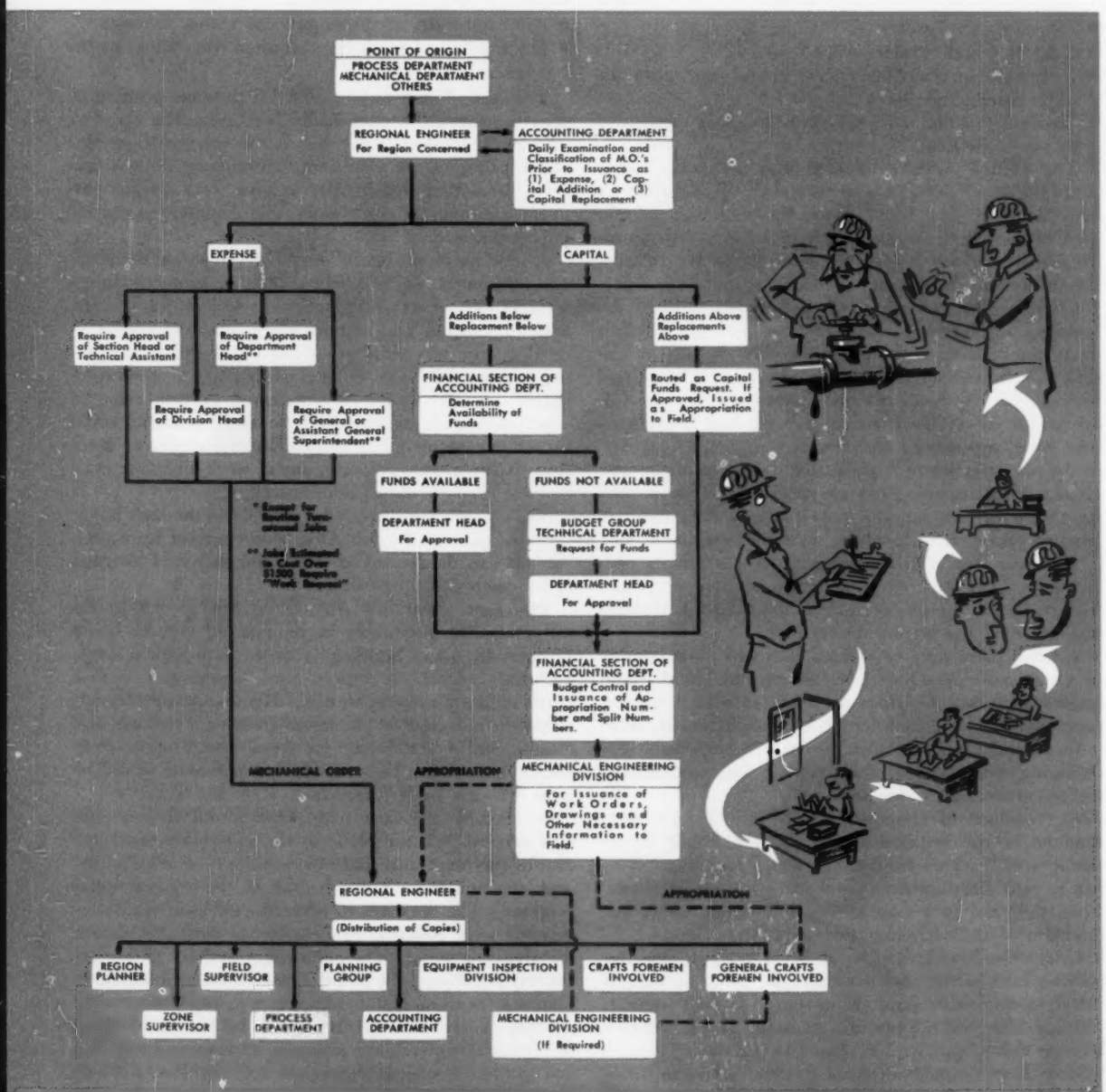
The Zones were directly responsible to the next larger division, called a Region. One zone engineer from each Region was designated as region planner and assigned full-time to work planning.

The area supervisor was to be housed within his assigned area, preferably in an existing control house or operating plant building, in order to provide a single personal contact to supply the "on-the-spot service needs of the process operators." His manpower requests would be directed to his region planner. Selection and assignment of mechanics to areas, based upon daily planning direction from the region planners, would be done by each craft foreman.

In starting the new plan, Esso found that it was necessary to "sell the plan" to the supervisors involved. Out-of-the-plant meetings were called to review the problems and make a rough draft of the organizational proposal. The supervisors severest criticisms and suggestions were solicited to develop all workable details for the new setup. These meetings proved to be extremely fruitful and a sound agreed-upon and workable plan was devised. Candidates for area supervisors were selected on the basis of ability and background related to the area involved. For example, an electrical foreman was chosen electrical supervisor for the Power Plant Area and an instrument foreman as area supervisor for an area encompassing complex operating units.

All supervisory personnel, in groups of 20 or less, were filled in on the plan and how it would work. After three months' development, refining and training, personnel in the plant were considered to be ready for the new system. All mechanics were acquainted with the new system and a 15-page cartoon booklet entitled "Who's the New Guy In the Picture?" was prepared to explain the system and how it would apply to each mechanic. Office facilities were supplied and the plan went into effect. The first observation was that no system can tolerate unassigned or overlapping responsibilities. These problems were corrected and, after nine months in operation, the over-all mechanical work efficiency had increased in the order of 20 percent.

Multicraft Mechanics. Esso's Bayonne, New Jersey refinery operates under an area system, using multicraft mechanics in each area.[7] The area supervisor works with 12 Maintenance and Construction mechanics who cross craft lines and perform whatever maintenance operations are necessary. The exceptions to the multicraft rule are electricians and instrument men. They



Esso Bayway's work order starts in the process department.

still operate on the traditional craft lines. There are three classes of multicraft mechanics—the helper, Second-class M & C mechanic and First-class M & C mechanic.

From 14 craft promotional units and 90 classifications, Esso's management created four groups of related crafts. Each crew is composed of men from the various classes so all skills are represented in each group.

Bayonne reports a 20 percent increase in Maintenance and Construction efficiency after they started this system. The mechanics' morale is greatly improved and he receives additional pay for this classification.

The old Bayonne zone system operated along craft lines with a general foreman over each trade but the area supervisor handled direct work in each area. The trouble was that foremen became personnel administrators. There was better field supervision but a dilution of supervisory craft know-how.

Area Supervisor. Since 1951, Esso's Baton Rouge refinery has used area supervisors. The area supervisor is assigned the full-time responsibility for all mechanical work in an area of one or more operating units. He is a first line supervisor and supervises all crafts. He is a resident mechanical supervisor, in the area, and is a single contact for process first line foremen and operators on mechanical work problems.[7]

Field Coordination is responsible for the work. (Note: This is the group that Esso Bayway found to be obsolete in 1953). This group determines which jobs shall be done, and when. They specify the number and type of craftsmen required for each job and coordinate and supervise the over-all job with assistance from the craft foremen.

Office and Planning furnishes clerical and stenographic assistance and long-range planning services to the divisions. The Field Coordination Group is divided into four divisions with a division engineer in charge of each. Three of these engineers are responsible for all mechanical work for specific process operations and one is responsible for work on a non-operating general plant facilities basis such as offices, laboratories, shops and roads. Each division is subdivided into zones which are the responsibility of a zone engineer. Six to 10 zone engineers report to the division engineer. The Zone is further divided into Areas which may include one or more operating units. The Area is the responsibility of the area supervisor.

Two four-area supervisors report to each zone engineer.

In the Mechanical Crafts, there are nine major craft divisions with a general foreman in charge of each. One to 4 division foremen assist him depending on the size of the craft. Two to 8 first line foremen are assigned to each division foreman and are responsible for the wage earners assigned to them. Each foreman normally furnishes men of his craft to specific zones of the plant.

In addition to the clerical and long-range planning work, this group includes turnaround coordination which consists of 6 to 10 supervisors who assist in the coordination of large-unit turnarounds.

It has been stated that the area supervisor system reduces the importance of the craft foreman. Actually, Esso Baton Rouge feels this is not the case. The craft foreman is very important because of his basic responsibility for the worker. Because the foreman is relieved of all the over-all work responsibility—except when specifically assigned as a job supervisor—he is in a position to concentrate on those matters dealing with the individual worker. Depending on the craft, he is responsible for 15 to 40 craftsmen, with an average of 38. The craft foreman travels around the areas in which his men are assigned, to check on worker performance by talking with the area supervisor. He is responsible for the individual craftsman's performance, training, tooling, work methods, safety and working conditions, and all personnel and employe-relations problems. In addition, he must see that each man's work time is properly credited for pay purposes.

Essentially, the area supervisor is responsible for the work and the craft foreman is responsible for the worker. Some of these responsibilities parallel each other, such as working conditions, safety, good housekeeping and work efficiency. To reduce conflict and provide an efficient and smoothly-operating organization, there must exist a very high degree of cooperation between the area supervisor and the craft foreman.

To answer the question, "Who is the craftsman's boss?" he looks to his craft foreman in all matters relating to his over-all performance, progress and pay. When he is assigned to a specific area, he looks to the area supervisor for specific work assignments.

This is another area in which close cooperation is required between the area supervisor and the craft foreman. They must consult each other on individual worker performance and problems. The area supervisor must keep the craft foreman appraised of all infractions of rules and worker inefficiencies and shortcomings so that the craft foreman may handle the problems with the individual. Only by full understanding can each carry out his function.

Foremen. Atlantic's Philadelphia refinery uses both area and craft maintenance. The craft foremen move around the refinery areas directing the special crafts under their jurisdiction. The craft foremen report to the area foremen for job coordination in each area.[9]

Both Humble and Texaco use the multicraft foremen system. There is no problem caused by the fact that the multicraft foreman is not highly skilled in craft work which he supervises because his job is to keep the crafts working—this takes leadership, not craft skill.[9]

Texas City Refining Co., Inc., uses craft foremen on a consulting basis. If the area foreman needs special craft supervisory help, he calls on the craft foreman to work out the problem. Under this system, the craft foreman handles grievances because each craft foreman not only acts as a consultant but also keeps the time of the men in their crafts.[9]

One important consideration in the use of craft foremen in large plants is that the larger the plant, the more difficult it becomes to rotate the craft foremen.

Foreign Organizations. Many different backgrounds, experiences, traditions and languages makes a maintenance supervisor's job very difficult in a foreign refinery. To these problems is added the usual increased maintenance required from repairing movie projectors to making an underwater patch on a tanker.

The Bahrain Petroleum Company's refinery uses an

area maintenance system and schedules the tradesmen into these areas on a day-to-day schedule which is based on weekly work requirements.[10] In this overseas refinery, located on the east coast of Saudi Arabia, personnel administration, training and human relations problems require major attention by the maintenance supervisors. One additional complication of a foreign refinery is the long vacations which are accumulated by maintenance personnel.

Operations. Brea Chemicals, Inc., feels that the Operations Department is the hub of its plant organization.[11] They have been given complete jurisdiction for responsibility of the plant facilities. Therefore, any work requests by any department must be approved by the operating personnel. The Operating Department determines the priority of maintenance work requests. However, there is a maintenance planner assigned to the operations coordinators who jointly plans the maintenance job priorities.

Work requests at Brea must be signed by the operator when he releases equipment to a maintenance crew. The maintenance mechanic must indicate his acceptance of the equipment as safe to work on by also signing a work order, however, maintenance mechanics can refuse to work on any job where safety of their personnel or plant equipment is in question.

Two operations coordinators (formerly shift supervisors) screen all routine work requests originating in the areas under their jurisdiction. They originate request forms to the Engineering Section requiring estimates and capital work management approvals.

The maintenance planner (former mechanic and maintenance supervisor) is the focal point of interdepartmental contracts. He and his staff estimate job sequences, crafts and manhours for all work requests and prepare bills of material for all work requests with the exception of those referred to the Engineering Section. He collaborates with the operations coordinator to adjust job priorities as necessary to synchronize maintenance repairs with the operation plan.

Urgent work requests are phoned into the planning office directly from the operating units.

Standby Work. Unless carefully controlled, it is very easy to get into a state of mind that a number of maintenance people should be kept around-the-clock to take care of emergencies, just in case something happens. There has been, in the past, a general tendency for maintenance personnel gradually to take over routine tasks which should be more logically performed by the operators. Years ago, at General Petroleum Corp.'s Torrance, Calif., plant, it was considered necessary to have maintenance personnel regularly make the rounds in certain areas to check bearings for overheating, to fill oil cups and to perform general lubrication of mechanical and electrical equipment.[2] Another example was the daily check made of storage batteries used in the electrical switch house on a 24-volt direct-current starting system. This was done every day and it occupied the full time of two electricians.

General Petroleum, and others, have now definitely decided that lubrication is a function to be performed by operating personnel regularly on shift and not by maintenance personnel.

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[10] Machin, L. E., "How Bahrain Is Maintained," PETROLEUM REFINER, 35, No. 1, p 133 (1956).
[11] Kinsella, Harry E., "Operations-Maintenance Coordination," PETROLEUM REFINER, 35, No. 1, p 241 (1956).

2. Planning and Scheduling

MODERN REFINERIES and petrochemical plants are subject to widely fluctuating demands and, therefore, involve intermittent peak maintenance loads. In order to handle these problems, a formal system called "planning and scheduling" has been devised. The two terms, planning and scheduling, are very closely related and are often discussed as though they are a single term. However, planning generally means a detailed analysis and description of a job with respect to how the work is to be performed, by whom, in what order, what materials and equipment are required, and the man-hours required for the maintenance mechanic. Scheduling simply means a procedure for determining when a job is to be started and when it is to be completed.

The really necessary contribution of planning and scheduling to a maintenance program is to provide the organization with effective controls over manpower and materials.

Better Planning. The term "better planning" has been widely used as a patented cure-all for everything which is suspected of being wrong with maintenance opera-

Like water down the drain, these men will cost you money unless their work is planned in detail.

tions. However, its importance is respected throughout the industry today. Consider a few examples of the results of poor planning. A tour around a refinery disclosed men marking time or waiting one-half hour or longer for material to complete the job.[1] Or, perhaps, the crew reports to work Monday morning and finds two major units down at the same time. Possibly a crew of men can be observed marking time and waiting for some carpenters to appear on the scene in order to erect a scaffold for them so that a tube bundle can be pulled. A half-completed job is stopped and started over again because someone has changed the signals as to how the work was to have been done. Men stand by waiting for equipment to be taken out of service and gas-freed instead of being ready for them when they appeared to start their work. All these things can be avoided by getting the proper information channeled to the proper people so that for any given unit of work everyone who is concerned knows the answers to the questions: how, what, where, who, and when?

Why Plan and Schedule? C. C. Carmine, Tidewater Oil Co., says that an average medium-to-large refinery handles approximately 30 to 50 job orders every day, with 4 to 800 man-hours per job, and 30 to 50 shutdowns per year ranging between 2,000 and 60,000 man-hours per shutdown.[2] Maintenance supervisors must direct 14 different craft skills requiring 2 to 5 different crafts per job, various classifications of workers from unskilled to skilled, three types of job priorities, juggle manpower because of vacations, sickness, etc., provide material at the job-site, and provide means to move men quickly between jobs to meet emergencies.

Can anyone handle this many details without planning? Carmine states that ". . . once you have decided to require written job orders instead of maintaining the plant on verbal authorization from the person making the loudest demands, then you are faced with the problem of bringing some order out of the now-documented confusion evidenced by the accumulation of an unsorted pile of written job orders." He says that the obvious solution to the problem is a system of planning and scheduling.

The Chemstrand Corp. at Decatur, Ala., believes that work planning is never wasted, even though the job may not be carried out as originally planned, because it helps them arrive at an alternate plan quicker.[8]

Work Authorization. The first step to be taken in gaining control over manpower and material is to have maintenance work authorized through a job order system, in writing. It is also desirable to have as few people as possible authorizing the work. In some plants, the Operating Department is primarily responsible for maintenance work authorizations. Therefore, the operating supervisors should initiate the work orders in these plants.

The job order contains a clear description of the work to be performed, the location and identification of the equipment, and an accounting code number as well as the date of availability for starting the work.

Work Order. At British Petroleum Company's Kent, England, refinery, all work requests go through the plant engineer and, if approved, he obtains engineering assistance such as drawings or sketches, procures material, checks into process conditions, and previous plant history of the equipment.[3] By referring to equipment cards, he can determine the history of the equipment.

On the reverse side of the work request he makes a job breakdown, sequence of operations, crafts required, and man-hour estimate. The work request then goes to the planning office which gives it a cost number and transfers the work request into a work order.

The work order is really only a typed copy of the work request. Each craft receives a copy, including any drawings, material lists, safety permits, etc., that they also require. After the craft foremen review the documents, they are sent to the area foreman in one complete package so that he can supervise the work.

Upon completion of the job, all records are sent to a coordination office where equipment history is extracted for history record cards.

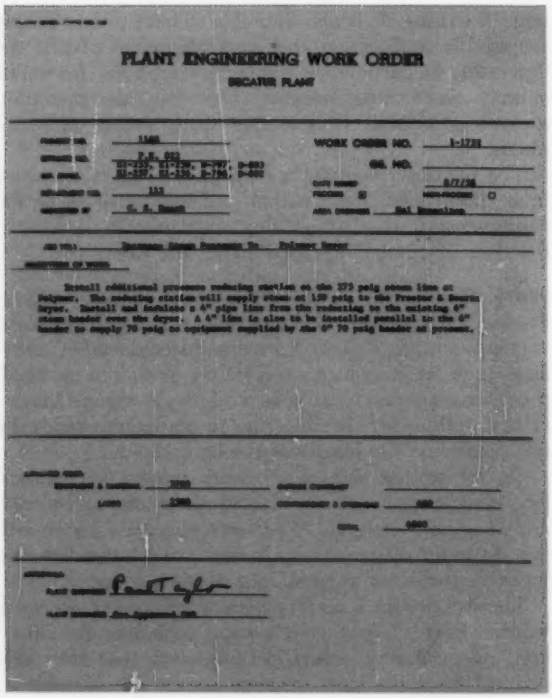
General Petroleum Corp. requires that any maintenance job requiring more than four hours for a mechanic and a helper must be authorized by a separate job order.[1] Anyone in their plant can originate a request for a job order, but it must be approved by an area engineer who is working in the area involving the job request.

Jodie Isenhower, of Humble Oil & Refining Co., Baytown, Texas, told the Plant Maintenance and Engineering Conference in Cleveland (1959)[4] that operators are not mechanical people and often-times request jobs that cost too much and are not as urgent as the classifications they request. Therefore, he said, Humble's Maintenance and Construction Division reviews all requests and refers some of them back to the originator for review to see if the job is justifiable or if the priority can be changed to permit deferring the work to a later date.

The Plant Engineering Work Order at Chemstrand's Decatur, Ala., plant briefly describes the over-all job.[8] A second sheet called "Detailed Description of Work" includes the order in which the job should proceed. A complete Bill of Material and Safety Check List complete the forms used in this plant. All of these forms are prepared by a project engineer before the work order and drawings are issued to the field.

Job Priority. One of the first things that must be decided about the job is the urgency with which it should

Chemstrand Corporation's Decatur, Ala., plant uses these forms for job planning



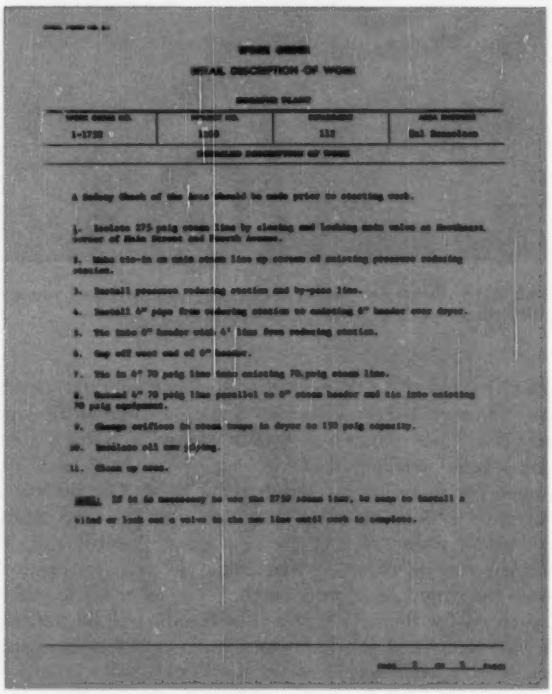
PLANT ENGINEERING WORK ORDER

DECATUR PLANT

WORK ORDER NO. 1-1732

Install additional pressure reducing station at the 375 psig steam line at Polymer. The reducing station will supply steam at 120 psig to the Preator & Fourth dryer. Install and insulate a 4" pipe line from the reducing to the existing 6" steam header over the dryer. A 4" line is also to be installed parallel to the 6" header to supply 70 psig to equipment supplied by the 6" 70 psig header at present.

Work order cover sheet describes scope of job.



WORK ORDER

DETAIL DESCRIPTION OF WORK

DECATUR PLANT

WORK ORDER NO.	PROJECT NO.	DEPARTMENT	AREA SUPERVISOR
1-1732	1360	112	Del Bennelson

DETAILED DESCRIPTION OF WORK

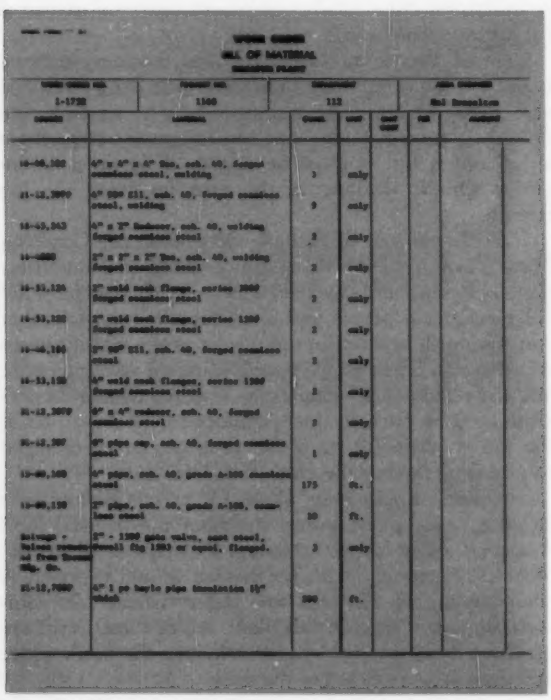
A Safety Check of the area should be made prior to starting work.

1. Isolate 375 psig steam line by closing and locking main valve on Southeast corner of Main Street and Fourth Avenue.
2. Make tie-in on main steam line up stream of existing pressure reducing station.
3. Install pressure reducing station and by-pass line.
4. Install 4" pipe from reducing station to existing 6" header over dryer.
5. Tie into 6" header with 4" line from reducing station.
6. Cap off west end of 6" header.
7. Tie in 4" 70 psig line into existing 70 psig steam line.
8. Extend 4" 70 psig line parallel to 6" steam header and tie into existing 70 psig equipment.
9. Change orifices in steam traps to dryer to 120 psig capacity.
10. Insulate all new piping.
11. Clean up area.

NOTE: If it is necessary to use the 375# steam line, be sure to install a tilad or lock out a valve in the new line until work is complete.

page 1 of 1 page

Description gives order of work performance.



WORK ORDER

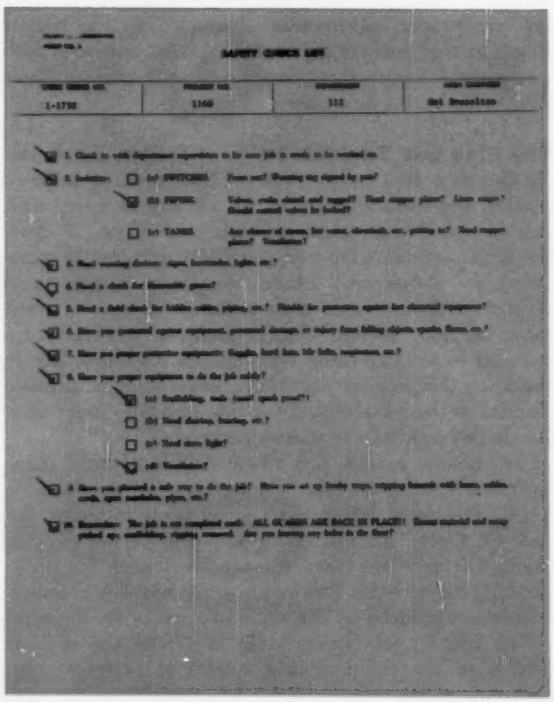
BILL OF MATERIAL

DECATUR PLANT

WORK ORDER NO.	PROJECT NO.	DEPARTMENT	AREA SUPERVISOR
1-1732	1360	112	Del Bennelson

CHARGE	MATERIAL	QUANTITY	UNIT	UNIT COST	PER	AMOUNT
10-08,102	6" x 6" x 6" Tee, sch. 40, forged seamless steel, welding	1	ea.			
21-12,3070	6" 300 ELL, sch. 40, forged seamless steel, welding	9	ea.			
10-03,043	6" x 2" Reducer, sch. 40, welding forged seamless steel	2	ea.			
10-0000	2" x 2" x 2" Tee, sch. 40, welding forged seamless steel	2	ea.			
10-11,120	2" weld neck flange, series 3000 forged seamless steel	2	ea.			
10-11,122	2" weld neck flange, series 1200 forged seamless steel	2	ea.			
10-06,101	2" 90° ELL, sch. 40, forged seamless steel	2	ea.			
10-11,110	6" weld neck flanges, series 1500 forged seamless steel	2	ea.			
21-12,3070	6" x 4" reducer, sch. 40, forged seamless steel	2	ea.			
21-12,307	6" pipe cap, sch. 40, forged seamless steel	1	ea.			
10-00,103	6" pipe, sch. 40, grade A-106 seamless steel	175	ft.			
10-00,130	2" pipe, sch. 40, grade A-106, seamless steel	10	ft.			
Salvage - Valves removed from Thermal Mfg. Co.	2" - 1500 gate valve, cast steel, Powell fig 1882 or equal, flanged.	2	ea.			
21-12,7080	6" 1 pc baytle pipe insulation 1½" thick	200	ft.			

The project engineer fills out this bill and requisitions the material.



SAFETY CHECK LIST

WORK ORDER NO.	PROJECT NO.	DEPARTMENT	AREA SUPERVISOR
1-1732	1360	112	Del Bennelson

1. Check in with department supervisor to be sure job is ready to be worked on.
2. Isolation: ☐ (a) SWITCHES. Power out? Warning tag signed by you?
   ☑ (b) PIPING. Valves, valve closed and tagged? Need copper plate? Lines empty? Should control valves be locked?
   ☐ (c) TANKS. Are sources of steam, hot water, chemicals, etc., gaining in? Need copper plates? Ventilation?
3. Need warning devices: signs, barricades, lights, etc.?
4. Need a check for flammable gases?
5. Need a field check for hidden cables, pipelines, etc.? Shields for protection against hot electrical equipment?
6. Have you protected against equipment, personnel damage, or injury from falling objects, sparks, flame, etc.?
7. Have you proper protective equipment: Goggles, hard hats, life belts, respirators, etc.?
8. Have you proper equipment to do the job safely?
   ☑ (a) Scaffolding, rods (need spark proof)?
   ☐ (b) Need electric, heating, etc.?
   ☐ (c) Need more light?
   ☑ (d) Ventilation?
9. Have you planned a safe way to do the job? Have you set up hoisty ways, rigging hazards with hoses, cables, cords, open manholes, pipes, etc.?
10. Remember: The job is not completed until: ALL GUARDS ARE BACK IN PLACE!! Excess material and scrap picked up; scaffolding, rigging removed. Are you leaving any holes in the floor?

Safety check list clearly shows safety procedures to be used.

be planned. Various refiners use different systems of job classification but all are essentially alike. Tidewater's Avon refinery uses three job classifications:[2]

- Immediately
- At some specified date
- At some date not initially specified but which may be established later

These classifications are also termed:

- Emergency
- No. 1 priority
- No. 2 priority

Mobil's Beaumont refinery uses four priority classifications:[5]

AA is the designation given emergency jobs. This classification does not necessarily apply to emergency work orders but to emergency jobs that are important enough to warrant overtime.

A classification is given to jobs that are essential for maintaining plant production and a safe operating plant.

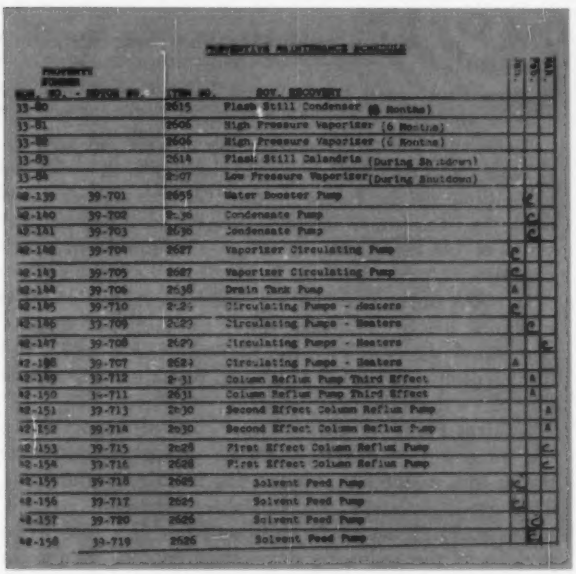
B classification is the priority given to jobs that should be done but are less essential than the previous classes of jobs.

C classification is given to backlog work and jobs that can be done during bad weather.

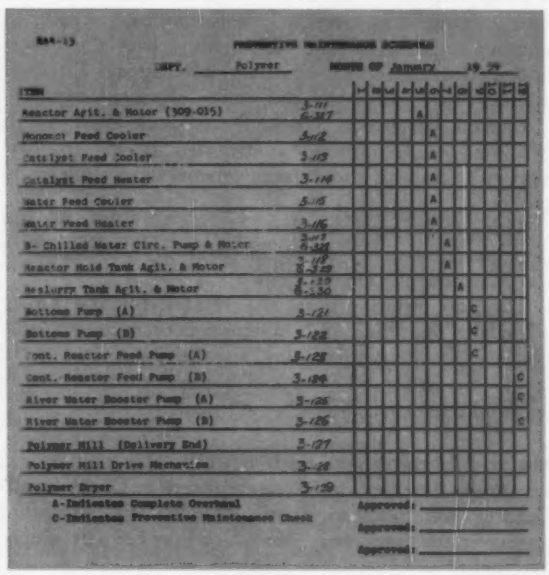
In addition to these classes of jobs, Mobil also uses a numbering prefix system such as 1A, 2A, etc., to indicate the order of importance of jobs within the various classes.

Preventive maintenance is given a top priority at Ethyl's Baton Rouge plant and is seldom rescheduled from preventive maintenance to normal maintenance work.[6]

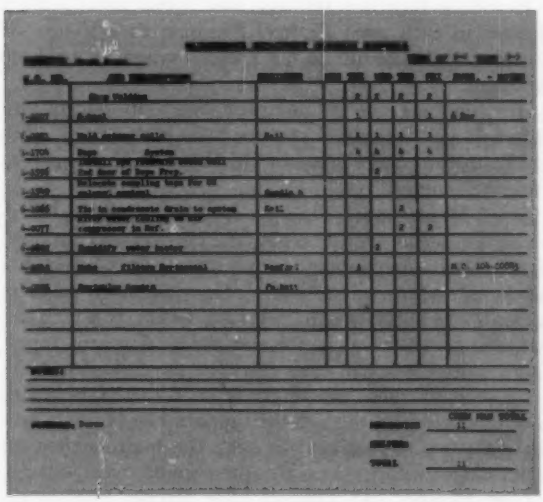
Minor Maintenance. For jobs that require less than 10 man-days work, Esso Bayway considers these minor



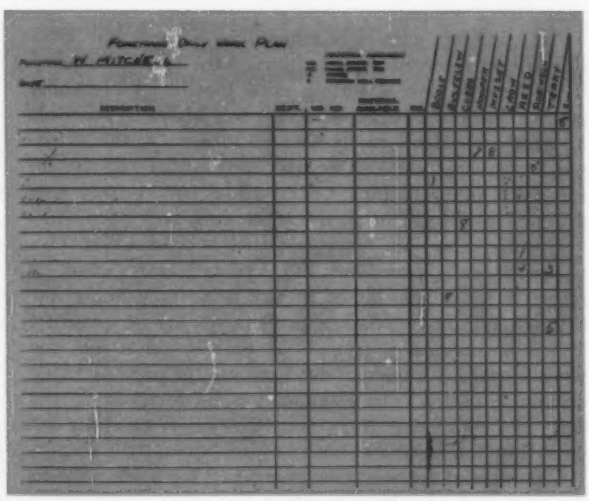
Master preventive maintenance schedule is made for one year, in advance.



The planning and scheduling group prepares this monthly preventive maintenance schedule.



A weekly job schedule is made each Thursday.



Each afternoon, the foremen prepare this schedule

maintenance, and usually they are originated by the process foreman.[7] Bayway's practice is to segregate a section of the Region's regular maintenance manpower for minor maintenance. This assignment is usually made on a tentative basis the day before the work is to be done. These men can be diverted by the area supervisor to emergency work with the zone supervisor's agreement.

Minor maintenance and repair jobs at Chemstrand's Decatur, Ala., plant are handled completely by the maintenance foremen who do all of the work planning and material procurement.

Special Maintenance. Another division of Esso Bayway's major maintenance planning consists of large improvement items and major repairs of a non-recurring nature.[7] These jobs generally require the same preplanning treatment as given a unit turnaround. Again, the planner must coordinate his schedule with the Process and Technical Service Divisions, Mechanical Engineering Division, Stores and the craft's representatives.

Capital Expansion Work. Some work done by the Maintenance Department is included as new construction or alterations and rearrangements to existing equipment.

This project work is often handled by a project engineer and sometimes complete planning is handled for the Maintenance Department.

The job orders are usually written for the project when the material and manpower become available. However, management may require these jobs to be completed in record time and higher priorities may be assigned these special jobs.[2]

Major Maintenance. Each morning the maintenance supervisor, foremen and area engineers at Chemstrand's Decatur, Ala., plant meet with Planning and Scheduling to review any emergency jobs which may have developed overnight.[8]

On Friday, the Planning and Scheduling Group prepares a weekly master priority list giving priority schedules for the following week, taking into account emergency work requests.

One problem with tight scheduling, according to Phillips, is that emergency jobs interrupt the scheduled jobs.[9] They tried a plan of setting aside mechanics to handle emergency jobs but found that it was better to schedule all of the available manpower and interrupt the schedule for emergencies. After operating under this system for some time, Phillips noted that emergency jobs dropped to 3 percent of the total work requests.

Humble uses an emergency job classification (E) where a real, immediate and serious hazard exists or where a large amount of money is actually being lost through failure to produce product quality or quantity. When a foreman puts an "E" priority on a job, the work is started immediately; however, to prevent indiscriminate use of this classification by foremen to get their pet jobs done fast, each "E" job is carefully reviewed by the foreman's boss.[4]

Chemstrand reports that emergency work amounts to approximately 5—15 percent of the total maintenance work they perform.

Routine Planned Maintenance. For routine maintenance work, the planner must answer all the questions included under work authorization and, in addition, provide the craft sequence, a brief description of the steps to be taken in performing the job, special instructions and information for other departments, lists of tools, equipment and materials, and when required at the job-sites, drawing and sketches as required. He must also prepare a time guide for completion of craft sequences and for material deliveries.[2]

The Maintenance Planner. When the planner receives a written job order, he will necessarily try to answer these questions:[2]

- What is the relative importance of this job?
- What crafts are involved?
- What is the sequence, and when should crafts be assigned to the job?
- What material is required? When will it become available?
- How many men are required in each craft and for how long?

Generally, the chief planner meets with the area supervisors and each morning discusses the work scheduled to be done on the following day. Of course, they know fairly well the available manpower for each day and the status of jobs being completed as well as shutdown schedules and job priorities.

It is the duty of the chief planner to resolve conflicts of similar priorities between different maintenance areas. Sometimes the conflict cannot be resolved so easily and he must apply to higher authority, perhaps top management for a decision on top priority.

Central Planning Office. Practically all plants today use some sort of central planning group to coordinate the various maintenance jobs being handled in the plant. This group balances the available manpower requirements daily. Tidewater's daily schedule lists jobs to be performed the following day, assignment of manpower and manhours by crafts, projected times where craft sequencing is involved, vehicles and equipment required.[2]

Humble's Baytown refinery uses seven zones with a planner in each zone. Central Planning coordinates the planning and scheduling and moves manpower between the zones.[9]

Humble uses one planner for every 36 hourly employes. If you include clerks, the ratio is one to 48. Phillips Petroleum and Canadian Oil Co., Ltd., use a similar planning method.

Chief Maintenance Planner. At Phillips' Adams Terminal, Pasadena, Texas, plant, the chief planner reports directly to the maintenance superintendent.[10] So, he has the same stature as the assistant maintenance superintendent. He holds weekly planning meetings which are attended by all maintenance and production zone supervisors. Major work in each zone for the following week is planned at these meetings. It is the chief planner's duty to decide on the relative importance of each production work request and to keep the maintenance superintendent informed on the progress of these jobs.

Zone Planner. At Phillips, this planner reports directly to the zone superintendent and indirectly to the

chief planner. He establishes a direct communication between the work group supervisors and the planners. He prepares a daily work schedule for his zone which is coordinated with the Operating Department. These schedules are sent to each multicraft area foreman in the planner's zone who makes final work assignment.

Tidewater's Avon, Calif., refinery uses a zone planner to plan maintenance and repair jobs not exceeding $1,000.[4]

Planning and scheduling at Tidewater, whether it is performed in the zones or by central planning, consists of the following:

- A general description of the work to be performed
- Man-hour estimates, by craft
- Craft sequence
- Any special instructions to other departments
- A means to deliver material to the site at the proper time
- Job priority
- A system of charging the job to the correct account
- Manpower availability and completion dates
- Drawing or sketches
- Time schedule for completion and material deliveries to the job-site.

Area Engineer. At Phillips, he reports directly to the zone planner. This is the Planning Department's direct contact with the first line supervisors. The area engineer acts as a liaison man between the Production and Maintenance Departments. He reviews all work orders for his area from an economic standpoint, and determines the best method of performing the work. He orders material, estimates manpower and sets up the sequence in which the job steps are to be performed. He can initiate work requests and can make the necessary engineering sketches on the job. He is also the technical advisor to the front line supervisor and the maintenance personnel.

Daily Schedules. Every afternoon, at Chemstrand's Decatur, Ala., plant, each maintenance foreman prepares a schedule for the following day's work, based on the Planning and Scheduling Group's general schedules.[8] Here individual mechanics are assigned to jobs. The foreman prepares a mechanic's daily work list which is a punch card, listing the job and a brief description of the work.

The daily work planning at Esso's Baton Rouge refinery starts with the area supervisor.[11] Working with the process foreman in his area, and with his zone engineer, he determines which jobs are to be done and when. All work requests from the process operator clear through the area supervisor. He determines requirements for manpower, equipment and materials for each job. If he needs assistance with these determinations, he consults with the zone engineer and the craft foreman.

The area supervisor's plan is submitted to the zone engineer. This plan shows each job and its order of importance and the number of men by craft required for each job. In addition, the plan shows the number of assigned men by craft required for routine minor maintenance work.

The assigned men handle minor maintenance jobs and preventive maintenance in the area and provide the area supervisor with a nucleus of manpower to work on any job in his area. The plan also shows the job charge number and the requirements for special equipment such as cranes, trucks, tractors, and the like. The area supervisor's plan is reviewed by the zone engineer and forwarded to the division office. There, a planning engineer with clerical assistance, binds the area plans into an over-all division plan for the next day. There are always more jobs than can be handled by the available manpower. Therefore, the planning engineer determines which jobs should be worked and which cannot be handled.

Finally, the division plans are combined into a refinery-wide work plan. This plan is made available at noon each day to all supervisors and shows, by job and area, the men and equipment required, by crafts, for each job to be worked the next day. The plan later is corrected by the area supervisor to show manpower actually used on each job and is used to distribute labor charges for accounting purposes.

Each craft division foreman assigns his first-line foreman to furnish men and knowhow to certain zones and areas. The craft foreman assigns his men by name and classification to report to each area supervisor the next day for work assignments in that area. It is his responsibility to decide which man has the knowledge and skill required for a particular assignment. He also must be sure that the proper tools are available for the job.

Each morning, the craftsmen report to the area supervisor for work assignment. He tells them which job is to be done, where it should be done, and gets them started on the work. It is his responsibility to be sure that the work can be executed efficiently and safely. The equipment must be made ready, permits obtained and materials, scaffolding and special equipment must also be made ready for the job at hand. If the work load is extremely heavy, individual craft foremen assist the area supervisor. The craft foreman may get the job started and move on or he may remain on the job as a job supervisor.

For emergency, unplanned work, the area supervisor may assign any of the workers in the area. If he does not have the manpower available, he may borrow men from another area supervisor in his zone. If manpower is not available in the zone, the planning engineer is contacted and he obtains the men by stopping work in some other zone.

Daily Work Schedule Forms. After the planner has completed his scheduling at Tidewater's Avon refinery, master forms are completed and copies distributed in the afternoon to area supervisors for work to be performed the following day.[2]

After the schedule is distributed, the planner ordinarily orders material for the following day's jobs or the area supervisors order the material from the storehouse.

The daily work schedule is also used by the accounting office to assign labor charges for each unit. If the work deviates from the schedule, pencil corrections will guide the accounting office in making the proper charge.

Daily Scheduling by Zone Foremen. Gulf's Port Arthur refinery divides its maintenance into three general classes:

- Running maintenance—includes routine repairs and preventive maintenance which require the same number of employes on assignment
- Miscellaneous maintenance—covers the shops and operation of trucks and other equipment

- Other maintenance—covers forces used on a turnaround and all other work not considered routine.

Gulf's daily schedule is prepared by the zone operating foreman jointly with the zone maintenance foreman. Gulf uses an operating department head in charge of maintenance to review the schedule with the zone craft foreman. The jobs are listed in order of preference and from this list the zone foremen agree on a schedule for the following day's work.[12]

Weekly Schedules. On Thursday of each week, the Planning and Scheduling Group prepares a weekly work schedule for the following week at Chemstrand's Decatur, Ala., plant.[8] Work requests are forwarded to Planning and Scheduling from area engineers, project engineers, maintenance foremen, and manufacturing supervisors.

Weekly to Daily Scheduling. Early in 1950, Ethyl's Baton Rouge plant changed from a weekly to a daily scheduling system, and was credited with reducing manpower requirements by 10 to 12 percent.[6]

Ethyl's system depends highly on the operators because they set the job priority and meet with the area foremen to prepare the daily schedule.

One feature of this system is that they over-schedule by about 10 percent the jobs for the next day. The reason for this is that in case a job is canceled or postponed, there will be sufficient work scheduled for the maintenance force. Unfinished jobs or postponed jobs from another day are rescheduled.

Manpower Surplus. If a manpower surplus should exist for a certain day, at Tidewater's Avon refinery, the planner will pull jobs from the backlog files.[14] Obviously, if the backlog file becomes depleted, and his manpower surplus lasts for too long a period, the indications are that the maintenance force is too high and that manpower reduction should be made.

Maintenance Manpower. At Esso's Bayway refinery, long-range major maintenance manpower estimates are based on process operating schedules.[7] Manpower in excess of these long-range estimates is available for regular maintenance in the areas. Each process unit in the refinery also makes a manpower guide for long-range estimates. At weekly meetings, scheduling engineers arrange for transfer of mechanics to meet the major maintenance manpower requirements.

Procuring Equipment. For non-stock material, Esso Bayway requires the planning engineer to procure the material for use in the areas.[7] Stock material is usually done by the area supervisor and in some cases by the mechanic on the job.

Material Planning. Getting the material to the jobsite at the proper time involves the Planning and Scheduling Group. They must provide methods, vehicles and equipment for handling the different kinds and sizes of material.

In the case of heavy materials, the Planning Department and storehouse work together in scheduling special vehicles and equipment for heavy material deliveries.

For light materials, the storehouse can make deliveries to the job-site as per the schedule set by the Planning Department.

It is almost impossible in planning a job to provide the exact kind and quantity of material needed. Therefore, it is important in eliminating idle time waiting for material to establish a fast material delivery system.

Procedures for ordering material for the storehouse should be set up with the fastest time available used. Many plants use the telephone in ordering materials for an area. The storehouse must maintain a good, current stock catalog, a copy of which is distributed to each area. Special material not carried in the catalog can be ordered by a special requisition number or the work order number, or by a brief description of the item.[2]

In planning for material, there are three items which must be observed:

- There must be planning for the correct quantity of material and the quality required
- The material must be scheduled for its availability at the job-site at the correct time
- There must be a provision for an effective delivery system between the storehouse and the job-site.

Shops Planning and Scheduling. Esso's Bayway refinery classified their shop work into three groups:[13]

- Construction work (capital improvement projects)
- Major overhauls (turnarounds)
- Regular maintenance.

Advanced planning can be easily made on the first two items, especially by planning the construction work so that it will not conflict with major turnarounds.

Man-Hour Estimates. Bayway found that shop estimates could be made on three bases:

- Estimating from engineering drawings and sketches
- Estimating on historical records
- Estimating by visual inspection.

They found that 25 percent of the shop load could be estimated from engineering drawings or shop sketches. An example of this type of estimating is pipe fabrication. Another 48 percent could be estimated from shop records. The remaining 27 percent of the shop work load could be estimated by visual inspection of each job.

Scheduling Shop Work. To establish a good shop schedule, so as to insure that the jobs would be completed when needed, Bayway set up two objectives, (1) they established realistic completion dates and (2) controlled the amount of work released to the shops. To achieve these objectives, they developed work schedules that considered the total man-hours of repair time for each job and the total time the work would be in the shop.

Shops Planner. At Phillips Chemical Company's Adams Terminal plant, the shops planner reports to the chief planner.[10] He prepares daily shop work schedules and assists in balancing the manpower throughout the plant. He also talks daily with each maintenance foreman to get a feel of the progress being made on all scheduled jobs.

The Small Refinery. Standard Oil Company (Indiana) maintains a refinery in Casper, Wyo. Its Planning and Scheduling staff consists of a general planning foreman and three maintenance coordinators, each of whom handles two maintenance areas and a shutdown coordinator. The maintenance coordinators and shutdown coordinator receive all work orders, except emergency orders, estimate manpower requirements, list material requirements, establish job priorities and schedules sequence of work.[15]

These ideas certainly do not represent all the refining or petrochemical superintendent's thinking on the subject of Planning and Scheduling. However, they do present a representative viewpoint. Adopt, modify or discard them as you like but, at the same time, remember that you have reviewed the modern Planning and Scheduling developments in the petroleum processing industry.

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3. Preventive Maintenance

PREVENTIVE MAINTENANCE is one of two choices that management must make to keep operating equipment in production. The other choice is breakdown maintenance.[1] The latter would be selected when obsolete equipment or an outdated process is being operated in marginal production or where no long-term schedule is expected.

PM Ingredients. Columbia-Southern Chemical Corporation's Corpus Christi, Texas, plant maintains that a successful PM program must develop the following ingredients:[2]

- A set of good maintenance records
- A mutual understanding between the Operating and maintenance Departments
- Maintenance mechanics who perform in a good workmanlike manner
- An adequate inspection program
- A good corrective maintenance program
- And, PM must have good administration.

Scheduling PM. Several opinions expressed at Phillips' gasoline plants were that preventive maintenance schedules would result in extra downtime as well as cost.[3] It was also the opinion that more manpower would be required. In actual practice, it has not resulted in any increased downtime nor has it been necessary to add personnel to carry out the schedule.

Previous to the preventive maintenance schedule, breakdowns were not uncommon and for long periods. After scheduled preventive maintenance was initiated, breakdowns have been minimized and have become the unusual rather than the common occurrence. On their more modern engines and compressors, the downtime for repairs is in general less than one percent.

This maintenance supervisor has two choices: run the equipment to breakdown or get to work on preventive maintenance.

Thus, Phillips Petroleum Company's Natural Gasoline Department feels that preventive maintenance can be justified even if it does not reduce maintenance costs because of a reduction in downtime.

Ethyl's Baton Rouge plant schedules 20 percent of its work as preventive maintenance. Fifty percent of its electrical work is on a preventive maintenance basis.[4]

Most plants report that between 10 and 20 percent of the total maintenance work would be classed as preventive maintenance.

Some companies, like Du Pont, feel that most shut-

down work is preventive maintenance. Others feel that at least part of a shut-down or a turnaround should be considered preventive maintenance.

Evaluating PM. Columbia-Southern uses the following measurement yardsticks for comparing the effectiveness of their preventive maintenance program:

- A ratio of emergency repairs to total maintenance
- A ratio of overtime to total hours
- The percentage compliance with the daily work schedule
- A ratio between actual plant production and its rated capacity
- The number of maintenance man-hours per unit of production
- The frequency of maintenance jobs on similar equipment and in similar units
- A ratio of PM to the total maintenance work load.

Try any one of several of these yardsticks over a period of time and check the effectiveness of your PM program.

New Program. If continued operation is expected for production schedules, you must use preventive maintenance.

Here are a few *preliminary* steps to a well engineered program:

- Start your PM program as simply as possible
- Tag each piece of capital equipment with a numbering system.
- Refer to all equipment by this assigned number
- Make a history card and cost card and file in permanent holders
- Provide proper storage for parts and supplies
- Make a catalog of stores inventory
- Keep records up-to-date
- Put all equipment in good operating condition before establishing preventive maintenance on it.

In *starting* new PM programs, follow these six steps:

- Provide an adequate maintenance budget
- Set up an equipment record system
- Check on the condition of existing equipment
- Develop adequate stocks of replacement parts
- Plan maintenance shutdowns well in advance
- Follow approved maintenance practices.

INSPECTION

Preventive maintenance should start on the drawing board when the equipment is selected. The next step is inspection of the new installation to be sure it meets the design standards and specifications. This is followed by a program of inspection during the life of the equipment.

Practically all preventive maintenance work is related to inspection.

Through inspection you can detect troubles with equipment while it is in operation. For example, routine inspection by a first-class mechanic is made every three months at Columbia-Southern to find defects detected by light, sound or touch while the unit is operating.

The inspection techniques at Tidewater's Avon refinery include visual inspection, mechanical, calibration, pressure tests, corrosion buttons, tree panning, safety drilling, X-ray, and ultrasonic tests, dye penetrant inspection, vacuum-seam testing, magnetic particle inspection, and pipe-leak detectors.[5]

Tidewater keeps a written record of measurements and conditions found in their scheduled preventive maintenance inspection of pipe lines, furnaces, towers, vessels, tanks, wharves, buildings, fences, power and lighting pole structures, condenser boxes, cooling towers, and heat exchangers. During a scheduled shutdown, the Inspection Department checks on all the facilities made available by the Operating Department.

The records made during and after an inspection are essential; because by checking them over a period of time, you will be able to find the cause of defective equipment.

Check these steps in your program:

- Inspection
- Record Results
- Review History
- Recommend Improvements.

Non-Destructive Testing. Some of the inspector's PM problems may be solved with ultrasonics.[6] During the past 10 years, this method has gained popularity as a rapid, reliable means of testing materials for possible failure.

High frequency sound waves can be traced through material by coupling the sound producer to the material. They can also be reflected as light waves.

A vibrating quartz crystal produces the sound wave of the proper frequency and then, in turn, acts as a receiver for picking up the reflected waves and changing them back to electrical impluses. A cathode ray screen shows the reflected waves as a "pip."

Studs. The failure of stud bolts can cause serious damage. Steam leaks, gas and liquid leaks are a few of the costly results of stud bolt failure. By applying the proper ultrasonic technique, these stud bolts can be tested without removing them if one face is available.

On certain items such as shafts, couplings, bolts and flanges, a history of ultrasonic tests may be maintained and compared with previous tests to determine the possibility of failure.

Pipes carrying corrosive substances can have their wall thickness measured easily with ultrasonics. A history of the test will reveal when the wall thickness approaches the danger point and it can be removed before serious failure occurs.

Other Test Methods. Other methods of non-destructive testing such as magnetic particle testing, dye penetrant, and radiography should be used to compliment each other. For example, if the sonic test operator discovers a defect in a material, he is faced with the problem as to whether or not the defect is only a tool mark or a crack. A shallow tool mark will not show up under the magnetic particle test or the dye penetrant test. Therefore, by using several tests, the inspector is able to determine the exact nature of the defect.

Test Records. An effective non-destructive test program must include an accurate record system. If no

such records exist, such a system should be installed because all subsequent interpretations are made from past records. After a record file is established, a systematic method of repetitive tests should be established.

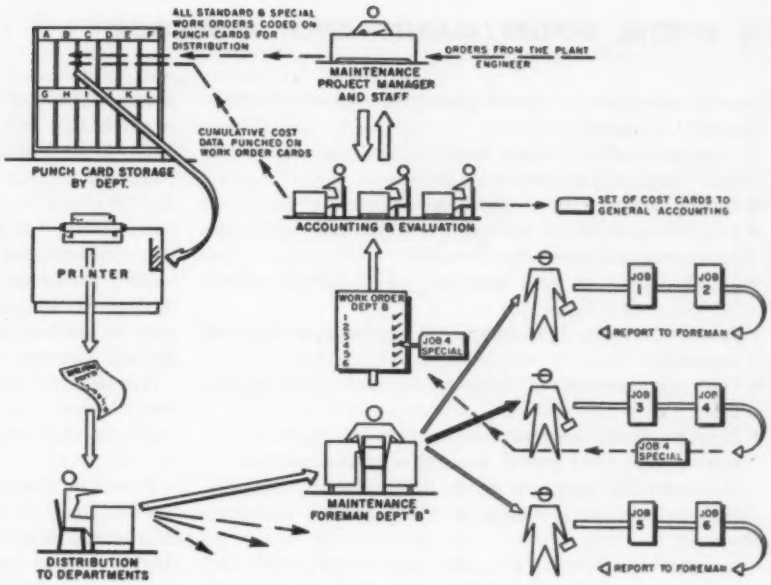
PM RECORDS

Mobil in Beaumont says that PM records, consisting of a basic code system, should be simple and easy to indicate the degree of maintenance being done.[1] For example, a basic code would be:

1. Lubrication and inspection
2. Inspection of oil condition, alignment, rod wear, etc., not requiring complete disassembly
3. Check of operability of safety devices
4. Complete overhaul

If these code numbers are listed for each piece of equipment, it is easy to determine the extent of maintenance done on that equipment.

Since Phillips' accounting procedure provided cost records before the use of preventive maintenance schedules, as well as after, it has been possible to determine the results of preventive maintenance in actual dollars. Year by year, there has been a continuous reduction of maintenance costs in actual dollars.



Electronic data processing machines can upgrade your preventive maintenance program by speeding up your records system.

Data Processing Machines. One author suggests employing electronic data processing machines for a three-phase preventive maintenance cost system.[8]

Phase 1 consists of the preparation of a cost analysis on all equipment in the plant. This would include all past maintenance records, latest available manufacturers recommendations, maintenance standards, and a review of maintenance procedures.

Phase 2 would consist of compiling a master maintenance file. This file would include all pertinent information on each item of equipment in the plant, type, location, function, etc.

Phase 3 would be devoted to segregating, coding, and entering on punch cards data obtained in Phases 1 and 2. Once these stages are accomplished, the flow of information and corresponding performance will work similar to that shown in the figure.

Manufacturers' Records. All manufacturers maintain extensive records of their products. If there is a question of application on a particular piece of equipment, or if the service has been changed, or if the equipment is failing in the service for which it was designed, contact the manufacturer and let him advise you if the application is correct and what steps can be used to correct the condition.[9]

Service Life. Mobil feels that a true preventive maintenance program means using various wear indicators to establish wear limits and equipment life.[7]

The following methods can be used to determine equipment service life for a preventive maintenance program:

- Make an equipment performance test for each piece of equipment which would become the base of future operating tests.
- Establish a test procedure which will quickly and easily locate operating troubles.
- Review daily operating reports as indicators to find approaching troubles, such as the variation in temperature on heat exchangers.
- Look at the daily maintenance reports to establish a frequency of failures on certain types of equipment.
- Plot curves on compressors to find the decline in volume as wear takes place.
- Set up standard inspection procedures for locating wear spots. For example, boiler and heater equipment where external tube inspection can prevent a rupture.
- Check on other plants and equipment service experience as a guide as to what may be expected.
- Establish a record system to evaluate your own preventive maintenance program.

Overhaul PM. Some overhauls which are not done for repair can certainly be classified as preventive maintenance. This is usually done not on a predetermined interval but by the use of a "tickler" file, especially on large complex equipment.[2]

Preventive maintenance is only a part of a good overall maintenance program. It goes right along with good planning and scheduling, a good work order system, and the other chapters contained in this Handbook.

PLANT PM

Housekeeping. Continental Oil Company's Ponca City, Okla., refinery is recognized as one of the best examples of housekeeping in the business. They feel that good

housekeeping is an essential prerequisite to an efficiently operated refinery.[10]

The methods Conoco uses to educate and instill sound housekeeping practices include:

- A program of preventive maintenance
- Regular painting of equipment to maintain good appearances and avoid deterioration
- Quick repair of leaks such as pump glands, valves, flanges, steam lines, etc
- Provide modern housekeeping tools, equipment, and materials
- Frequent mowing of tank farms and grass-covered areas
- Provide suitable receptacles for discarded papers, cardboard, rags, food scraps, and other waste materials.

To make the program work, these practices are discussed in regular meetings with supervisors and employes.

A good housekeeping program requires teamwork and there must be full support from all levels of management and employes. The key man is the front line supervisor. But he must be fully supported by management in his housekeeping decisions.

Weed Control. As operating companies acquire more and more land for new facilities, weed control problems multiply.[11]

Check these steps to see how your weed control measures up:

- Applying the right chemicals at the proper time of the year in the correct dosage equired for the soil involved
- Supervise the application and reinspect to touch up growth spots
- Carry out the program for five years or longer to spread out costs over an extended period.

EQUIPMENT PM

The Electrical System. Standard Oil Company of Ohio's Cleveland refinery experienced two costly electrical power outages from faulty relay coordination.[12] After this happened, they realized that a program of preventive maintenance for testing, resetting, and coordination of relays was essential.

Sohio feels that these points should be kept in mind when setting up a maintenance program on relays and circuit breakers:

- Have complete knowledge of the components and characteristics of the electrical system. A comprehensive survey may be necessary
- Develop testing standards and procedures
- Set up a training program for the men who are to do the work
- Prepare a schedule which will satisfy conditions found in the plant
- Devise a simple method of recording the test and inspection data
- Be receptive, always, to any changes or adjustments to the program which will assist in attaining the goal of zero outages per year because of faulty relay or circuit breaker operation.

Motors. A preventive maintenance program must obviously be built around a systematic and regular check of parts that are susceptible to deterioration and wear.

A motor inspection program would include a complete set of records of motor wear.[13] The inspector should check for abnormal noises and for above-normal temperatures, as evidenced by feeling the frame or by the characteristic odor of overheated insulation. This history would be noted on the records for future comparison. By keeping the motor clean and free of oil that may be spilled during oiling, slow or continuous leaks through bearing seals or oil fittings are easy to detect.

Freedom for the motor shaft to expand with temperature change is extermely important. Therefore, the end play should always be checked to be sure that the shaft is free.

When a new, or recently repaired motor is put in service, frequent checks of the bearings should be made during the first few hours of operation. These checks should include temperature measurements on the bearing housing, or in the oil reservoir. After two or three hours of continuous running, the bearing temperature may be expected to level off at a temperature 10° to 20° C above ambient temperature.

At infrequent intervals, all bearings in standard applications should be checked with a thermometer and their temperature rise recorded. A replacement bearing can then be allowed an equivalent rise before corrective action is taken.

An excess of oil in a sleeve bearing is never the cause of heat generation; oil not used for actual lubrication will assist in carrying heat generated in the bearings. On the other hand, an excess of grease or oil in ball bearings is a direct cause of heat generation in the bearings. It is often cause for serious trouble. (Noise emitted by an overgreased bearing is usually of a whining or squealing character.)

One simple but strictly temporary remedy for lack of end play, which can be applied without stopping the motor, is to loosen the bracket bolts at either end, being careful not to disengage the rabbet fit in the frame. An axial separation of only a few mils between the bracket and frame may relieve the thrust load and reduce the temperature to a safe level.

Electrical Equipment Records. Equipment records for motors, starters and controllers, are maintained by a clerk in Tidewater's Electric Shop.[5]

Motor servicing is handled through a "tickler" file system. Each year a schedule lists the motors which are to be serviced weekly during the year. The zone office clerk using his "tickler" file tells the zone planner which motors are to be serviced the following week. The record of motor servicing is entered on a card by the mechanic and is forwarded to a permanent recording.

Instruments and Controls. Equipment records are kept on relief and control valves at Tidewater's refinery at Avon, Calif. The valves are serviced, where possible, on schedules accompanied by a check-off list. All relief valves are checked and tested at least once a year.

Process Pumps. Several years ago, Sun Oil Company's Marcus Hook refinery noted that the lowest maintenance costs of all their areas were in a zone in which

pumps were given an annual "teardown" for preventive maintenance inspection and repair.[14]

The inspection required a thorough examination for pump body erosion, cavitation of the impellers, clearance of the case and impeller rings, the fit of ball races in the casing and on the shaft, gasket surfaces, packing gland bolt, head or joint bolts, threads on plugs, sample and gage connections, and pipe strains.

Routine inspection included checking the pumps for vibration, bearing and coupling lubrication, condensate in the bearing housings, condition of cooling water lines and jackets, condition of the piston rods, packings and sleeves, etc. In addition to the mechanical inspection, a close check was kept on performance, operators were consulted, pressure gage and meter readings were checked for pump operating efficiency.

In another area, pumps were only lubricated on a regular basis; and during shutdown, the pumps were overhauled only if mechanical faults were indicated.

Records show that the latter method of pump maintenance resulted in the highest area maintenance cost for pumps in the refinery.

Sun found that a good pump PM program included morale, because if a great percentage of their time was on scheduled repairs, instead of emergency repair, the mechanics had a feeling that they were controlling the equipment instead of letting it run them.

The three main features of Sun's practices are to establish a regular schedule of internal inspection for pumps. Each individual pump may be considered to establish the period but it should be completely inspected annually. A good set of records of repairs is required for each pump. Good communications between the shop, field and technical groups is essential for a smoothly-operating program.

Heat Exchangers. Union Oil of California says that a large part of the responsibility for PM on heat exchangers is dependent upon the Operating Department because they perform many measures to prevent or retard corrosion.[15] For example, ammoniated water wash and air ejection was used to prevent hydrogen attack. Hydrogen probes are located in critical points and are observed and recorded by the operators. They also control pH by injecting ammonia organic inhibitors in crude topping and thermal cracking units.

To extend the life of exchangers in salt water service, tubeside velocities are maintained at three feet per second and water temperatures not allowed to exceed 120° F. Marine life and foreign material must be screened. Air must not be entrained in the system.

The Operating Department also controls cooling tower corrosion by adding water treating chemicals.

To further assist the Maintenance Department, the operators provide maximum operating conditions of temperature and pressure, for which the exchangers are to be maintained.

The preventive maintenance program includes inspecting the equipment, keeping progressive records of its condition, ordering replacement parts, and recommending repairs and improvements.

When an exchanger is inspected, the fouled condition of the bundle is recorded as it is removed from the shell. After cleaning, it is the inspector's responsibility to anticipate further corrosion. All of the standard testing instruments are used on exchangers and under certain conditions, samples are removed for metallurgical examination.

The exchanger bundles can be celaned by hydro-sandblasting which shortens cleaning time by 50 percent. After cleaning, the bundle is shop tested for leaks and returned to the unit. Union says that exchanger bundles are either scheduled for partial or complete retubing after cleaning because they feel that it does not pay to replace one or two tubes at a time, except under unusual circumstances.

Protective Coating Program. Dow Chemical Company's Freeport, Texas, plant has installed a protective coating program that practically eliminates guesswork on painting schedules and decisions on when, where, how, and what of a plant painting program.[16]

The key to this program is a Paint Committee. Their success, in turn, relates to the research this committee did in the causes of atmospheric corrosion and the testing which they performed on many types of coatings and materials of construction.

One idea that Dow used to establish a corrosion pattern was a series of tests on a plant-wide basis. They erected 150 wooden poles, 10 feet high, to which were attached coupons facing in four compass directions. Weight losses of the coupons were checked regularly and points of equal corrosion were plotted on a map to give a corrosion contour map.

These maps give a pictorial definition of the severe corrosion areas in the plant and also indicate which areas are not severely corroding.

Lubricants. Phillips Chemical Company's Houston plant decided to reduce the thirty types and grades of oil and five grades of grease they were using.[17] With the possible exception of electric motors, it was felt that one grease, an NLGI Grade 2 lithium base multipurpose grease would do the entire job. The plant oiler would need one grease gun, one type of grease and one type of grease fitting.

They divided their 30 different types of oils into four categories, these being white USP grade mineral oils, straight mineral oils, compounded gear oils and extreme pressure gear oils.

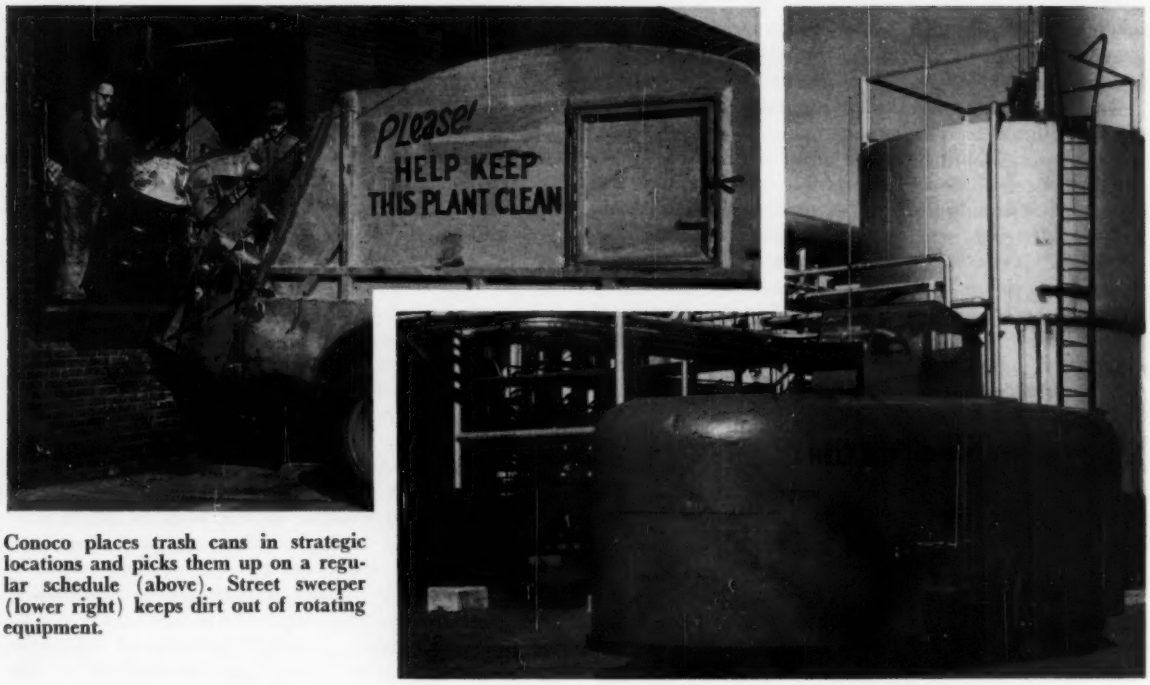
Phillips feels that this may be an oversimplification but that it is easier to add a required lubricant than to take one off the list after it has been established.

Lube Oil Analysis. Mobil's Natural Gas Department has found that a few simple lube oil tests can indicate serious trouble ahead in their engines and turbines.[18]

If you do not use lube oil analysis, you are faced with the problem of when to change the oil in your engines and turbines. The standard tests recommended by Mobil will cost $10 for turbine oil, $15 for engine oil and $41 for a complete test if something wrong is indicated. This is a cheap price when you consider that some engine lubricating systems require as much as $250 worth of oil. It's also a cheap price when you consider that this kind of preventive maintenance can save considerably more if the lube analysis spots a failure about to take place in the engine or turbine.

The first step in lube oil analysis is sampling. Mobil points out that the point of the sampling should be on

Good Housekeeping Will Pay for Itself



Conoco places trash cans in strategic locations and picks them up on a regular schedule (above). Street sweeper (lower right) keeps dirt out of rotating equipment.

the oil return line to the engine because everything that has been done to the oil including contamination from an outside source will be reflected in a sample of oil taken at this point.

Mobil sends a data sheet to the lab with the sample. This sheet gives information about the operating conditions such as water and lube oil temperatures, the type of filter and the date it was changed, the type of oil and operating hours since an oil change. This data along with the lab analysis is used to interpret the test results.

Mobil has found that an oil sample should be taken every four months on their large engines and turbines. These are staggered so that some samples are sent to the lab each month.

Experience has shown Mobil that tests on viscosity, water percent by weight and the neutralization number are the best indicators for engine oils. For turbine oils, the water percent and the neutralization number are the most useful tests.

Viscosity. This test measures the resistance to oil flow caused by internal friction. If the tests show an increasing viscosity, the oil is probably being oxidized by excessively hot bearings, blowby of hot gasses, or too high operating temperatures. A decreasing viscosity indicates dilution of the oil possibly from an outside source.

Water percent by weight. The water content of the oil should always be "nil." Even a trace should be cause for immediate action. If combustion water condenses on a cool cylinder wall, it can be wiped by the piston rings into the crankcase. Low water jacket temperature can cause this condensation. Low lube oil temperatures and poor crankcase ventilation can cause water vapor blowby to condense in the crankcase. Water leaks in the oil coolers and cooling water jackets would also be possible sources of water as shown by this test.

Neutralization number. This test measures the acidity of the oil. By comparing the neutralization number of the original oil with that found on the test, Mobil can interpret that for an increasing number, excess oxidation is going on in the oil and the cause should be found.

Records. Mobil plots these tests for each engine and can easily see a trouble spot when one or more of the tests show a jump on the curve. To make the plots more meaningful, they plot the results against thousands of operation hours and also plot lube oil consumption which has a direct relation on the test results.

Examples. On a two-cycle natural gas engine, Mobil found in one test that the oil contained some water. This was traced to low lube oil temperature caused by a faulty temperature controller.

On another four-cycle natural gas engine, water was found in the lube after 13,000 hours of operation. By raising the temperature on the engine jacket water system and adding extra crankcase breathers, no water was found on the next test. After operating this engine for 30,000 hours, the viscosity and oil consumption increased. This indicated piston ring wear which was substantiated by a compression test.

After an engine overhaul on another engine, the viscosity and oil consumption increased very rapidly indicating oxidation and contamination of the oil. The trouble was traced to a set of piston rings that failed to seal and after blowby started, the rings stuck and the condition gradually became worse.

On three of Mobil's large steam turbines, an increase in both the water content and the neutralization number was noted after a lube analysis. A check on a common oil reclaimer serving all three turbines showed a ruptured steam seal which allowed steam to enter the oil.

One of the best examples of how a lube oil analysis test gave clues of malfunctioning engine parts was seen in a plot of a two cycle engine after operating 22,000 hours. At this time, the oil viscosity started rising slowly and the neutralization number took a sharp increase. A check of the engine scavenging air ports revealed that they were badly plugged with carbon. After the ports were cleaned, there was an abrupt drop in the neutralization number. However, the last test showed traces of water and the viscosity started going up again. During a general overhaul of the engine, one piston was found to be cracked. Its replacement solved the problem.

Mobil also uses lube oil analysis to check on the most effective filter to use on a particular engine.

Unfortunately, bearing wear detection has not been successful using the lube oil analysis tests. Mobil points out that by adding a spectrographic analysis to the standard tests, bearing wear could probably be detected in an early stage.

Mobil also points out that even though their lube oil analysis program has helped the maintenance people considerably, it is not the utopia in engine and turbine maintenance. It does not pinpoint troubles but when used in conjunction with other signs and indicators, many conditions can be detected before costly damage is done to the equipment.

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4. Inspection

SOME PEOPLE say that inspection causes high maintenance costs, and it's not easy to refute this statement. The reasons for believing this are reasonable because many of the pieces of equipment inspected do not need repairs. Therefore, the work done in inspecting the equipment, such as blinding, purging, disassembling, the inspection itself and reassembling seems to be wasted effort.

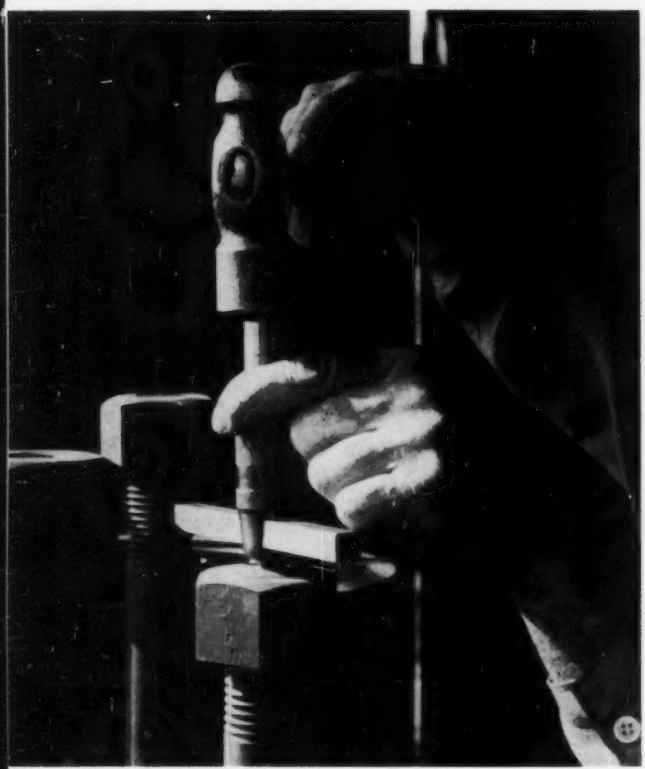
Another viewpoint is that inspection is preventive maintenance and as such should reduce costs. Not every item inspected reveals a serious defect; however, enough are found which can be repaired in time to prevent major failures. Such failure may cause extended shutdowns with the subsequent loss of costly production. Compared to a heavy production loss, inspection costs are almost negligible.

Inspection may cause unnecessarily high costs if (1) more safety work than necessary is done, (2) more actual inspection work is done than is needed, (3) and much more maintenance work is done than is necessary from a preventive maintenance standpoint.

Standardization and control are the solutions to holding these costs in line. That is, set up standard maintenance practices and appoint a supervisor to see that these standards are followed.

Inspection Standards and supervision would not allow the following to happen: example, a cast-iron tray in a fractionating tower was found to be cracked.[1] The bubble caps were hard to remove and showed slight traces of corrosion. With no standards and an ardent maintenance supervisor, the decision may be to scrap the tray and bubble caps. A careful analysis of the situation from a standards viewpoint, by a competent supervisor, and analysis of the operating records, might show that there was no loss of fractionating efficiency. A metallurgical examination might show that there was little likelihood that the crack would enlarge and an engineering analysis might show that there was no danger of a structural failure. Therefore, the life expectancy of the tray may be as good as any of the others which were not damaged. This is an example of inspection paying its way.

Inspection Records. Practically all companies agree that records are essential to inspection. D-X Sunray uses record sheets with a small drawing of each part.[2] For example, the shell cover of an exchanger is shown in a simplified drawing and all of the corrosion, erosion, and wear points are shown on the record sheet. By accumulating this information, the service life of each



For checking stud hardness . . . a portable tester.

part can be estimated and repair time scheduled well in advance.

Delta Refining Company uses 12 x 18 inch tracing paper for their inspection sheet records.[3] Each sheet gives the pertinent data covering the pieces of equipment being inspected, such as material, operating and design pressure and temperatures, in addition to past inspection findings.

The inspector does not have to be familiar with the equipment because the inspection sheet gives him, by drawings and written information, complete details on thicknesses and internals of the equipment. Thickness readings are in tabular form so that rates of corrosion can be easily established.

Piping Systems. On piping systems, points are shown on Delta's inspection sheet drawing where metal thickness readings were taken. A tabular section on the piping inspection sheet makes it easy to compare thickness readings.

Field Notes. The inspector may find equipment that has been altered or new equipment installed since the last inspection for which there is no inspection sheet. He simply makes a field sketch and notes in rough form the thicknesses which are later transcribed to a new sheet for this equipment.

Fired Heater Inspection. A major furnace manufacturer recommends a monthly inspection for each heater while it is in operation.[4] This inspection should include:

- A visual check of the heater, inside and out
- An operating log
- Check on the heater instrumentation, including thermocouples, for proper operation.

The furnace parts requiring the most time to repair or replace should be inspected first. A good inspection order would be to start with the tube coil then inspect the tube-support system and other internals, the refractories, the breaching, the stack and finally the burners.

The corrosion rate for the tube coils should be closely checked because the frequency of shutdown is probably set by the tube coil. On a new furnace, measure the tube coil thickness at exactly the same spot after it has been on stream for six months, to establish the corrosion rate. Schedule another inspection for approximately one year later. From then on, spot measurements should be taken to verify the corrosion rate or when the tubes are approaching retiring thickness.

Esso's Bayway refinery has found that because of severe furnace conditions, their furnaces should be inspected thoroughly during each major shutdown.[5] In addition, they periodically inspect the furnace visually through the peep-holes. These visual checks help detect such conditions as sagging, bulging, hot spots and flame impingement. Immediate action such as re-aiming the burner may prevent serious damage.

During turnaround, the inspector thoroughly checks all radiant section tubes and the accessible preheater tubes for sagging, bulging, cracked or externally corroded tubes. Tubes that bulge on one side are watched very carefully and the tube is removed when stress lines or surface cracks appear on the bulged area.

A sagging tube in the radiant section is not considered serious unless it prevents cleaning or causes header boxes to jam and wedge against other boxes or against the sides of the heater compartment. Sagging in the convection section is more serious because tubes in the upper rows sag between those in the lower rows presenting a solid surface to the flue gases which prevents their free passage around the tubes. This is called "nesting" and if found, the sagging tubes should be replaced and alloy tube spacers installed under the new tubes to provide support.

Eccentric tubes, internally corroded, can be checked by direct thickness measuring instruments. They can also be checked with a tube micrometer when two different ID readings are obtained in the same location. This same reading will also indicate an "egg-shaped" tube. To determine whether the tube has been eccentrically, internally corroded or is egg-shaped, the inspector hammer tests the tube periphery at the suspected location. Caliper readings of the OD are also taken around the tube. Unequal caliper readings and uniform ring from the hammer test indicate an egg-shaped tube. Equal caliper readings and a non-uniform hammer ring indicates eccentric corrosion. If corrosion is suspected, the tube with the greatest variance in internal diameter is removed for a cross-sectional examination. During each major turnaround at Esso Bay-

way, representative header and return fittings are examined internally and externally for cracks, erosion, corrosion, or casting defects. For low pressure, low-velocity service, the square type header equipped with either threaded or tapered plug deflectors is used. Header wall thickness measurements are taken and the plug deflectors are checked for adequacy of thread engagement or seat bearing surface. Return bend type headers are measured for correct wall thickness and examined for erosion or corrosion on the inside or on the seating surfaces. Whenever tube renewals are required, the header serrations are inspected to insure that they are free from cuts, coking, or scaling. During each turnaround at Bayway, the furnace "settings" are thoroughly inspected, which includes checking the foundation, structural steel, tube supports, refractories and brickwork. The foundation is checked for spalled, cracked or deteriorated concrete; and the area where structural steel bars bear on the foundation is checked. The structural steel members are inspected for sagging, buckling, or misalignment, and the fireproofing is carefully inspected.

Burner Inspection. A routine inspection of the burner ports should include a spot check for soundness and correct size. A simple and effective gage is a drill using the size recommended by the manufacturer for port drilling.

Furnace Lining. If there are cracks of more than a hair-line separation they should be cleaned out and calked.

Final Check. Following up on furnace repairs after inspection is a simple but very important phase of the inspector's work. After repairs are made, the inspector's primary function is to insure that the correct materials were used and to check on the quality of repair work. In tube rolling, for example, he will check to be sure that the I.D. is rolled neither too great or too small.

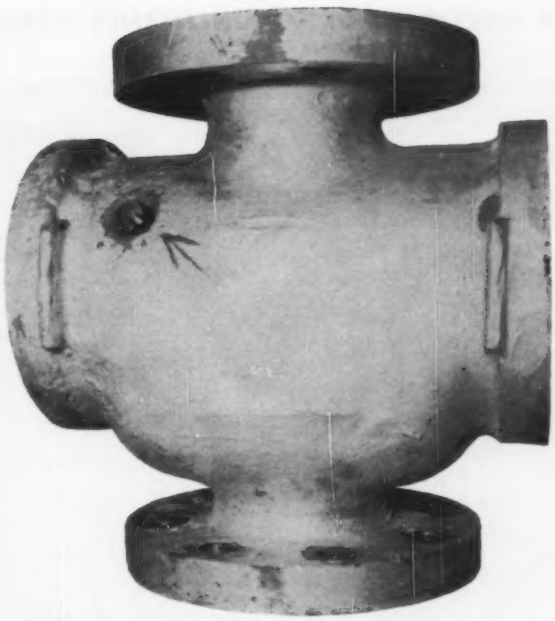
The final job of the furnace inspector is to recommend any changes in furnace operation that he feels will cure future troubles.

Inspecting Vessels. Periodic inspection of unfired pressure vessels in Gulf Oil's Philadelphia refinery consists of making the following examinations:[6]

- Thickness calibration of heads and shells
- Welded and/or riveted joints are examined internally and externally
- Small sections of insulation are removed and joint checks are made
- Vessel linings, trays and internal components are checked
- Certain nozzles are calibrated
- Safety valves are overhauled
- Extension and brickwork are checked
- The vessel is hydrostatically tested.

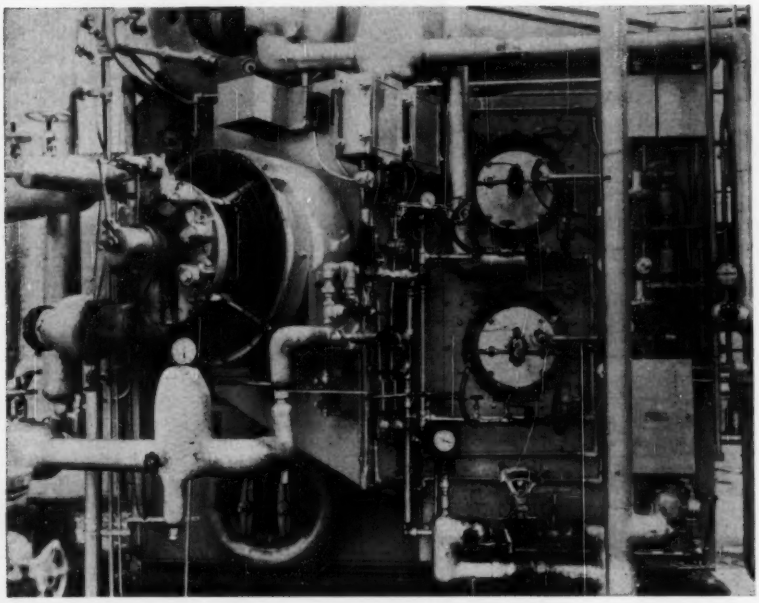
Gulf uses corrosion washers, drilling and calipering, ultrasonic test equipment and over-flange calipers for finding the head and shell thickness.

Shell Thickness. Gulf's practice is to install corrosion washers on new vessels. On vessels that have been in service, the wall is drilled and calibrated with a hole caliper. The drill hole is plugged and welded and the corrosion washer welded to the vessel wall. Initial readings are taken of the distance between the washer face and the vessel wall. Either monel or type 316 stainless steel washers are used, depending on the service. If no washers have been installed, an electronic thickness calibrating instrument is used for checking previous drillings or the original calibration. If appreciable metal loss is found, the vessel is drilled and measured. Gulf recommends that a large number of readings be taken on large vessels, such as absorbers



This depentanizer reflux control valve was badly eroded. A hammer test made the hole and exposed the thin wall.

This crude service tee had an original wall thickness of one inch. Hammer tests revealed spots as thin as one-quarter inch.



Monthly furnace inspection should check on: general condition, inside and out, the operating log for suspected defects, and the furnace instrumentation including thermocouples, for proper operation.

and fractionators, especially in the feed and reboiler return areas.

Shell Inspection. Here are some hints on shell inspection:

- Visually inspect the shell by placing a flashlight against the wall so that the light just grazes it
- Washed or eroded areas may be detected by the use of templates or straight edges
- Note the welded joints in trays, as a guide to metal loss
- Make a special effort to check carbon steel vessels operating at high temperatures (reactors) noting the condition of the welded joints
- Magnetic particle examination and cut samples for laboratory analysis is often done
- In checking a vessel where there is a suspicion of cracking, be sure to sandblast the weld seams
- For general inspection of vessel shells, try using a hand scraper to remove coke and scale to the bare metal[7]
- If thin spots are found by hammer testing the vessel, drill test holes and measure the wall thickness. Steel plugs can then be screwed in the test hole and welded in place.

Nozzles. Check nozzles internally and externally and calibrate them. If the nozzle wall shows a substantial metal loss, recommend that a lining be provided. Later, check the lining for bulging and wear.

Hydrostatic Tests. Gulf believes that unfired pressure vessels should be tested hydrostatically at a pressure one and one-half times the safety valve setting. With the vessel blanked off, it is slowly filled with water and pressure applied when the metal temperature is the same as that of water. If the hydrostatic test must be performed in freezing weather, use light oil instead of water to prevent freezing. Visually inspect all openings and joints for leakage when the correct pressure has been obtained.

Heat Exchangers. In inspecting the exchanger, prior to pulling the bundle, the shell cover is removed and the bundle is checked for leaks by applying water pressure on the tube side. If a leak is observed, the shell cover is replaced and the channel cover removed. Water pressure is then applied to the shell side so that the leaking tube can be located.

All bundles are pulled by Eastern States Petroleum Company's Houston refinery from the shell past the second baffle.[8] If cleaning or tube repair is necessary, the bundle is not pulled completely out of the shell (instruments are not used at this plant for testing bundle tubes). The channel head is visually inspected, and the channel, floating heads and the shell are calipered with G-gage calipers. The shell is also hammer tested and a test hole drilled if thin spots are suspected. After drilling, a finger caliper is inserted in the test hole to measure the shell thickness.

Pump Inspection. There are two reasons for inspecting pumps: because they are leaking and to insure continued operation and efficiency.

When a pump is handling hydrocarbons and is leaking, the serious possibility of a fire always exists. The most common sources of pump leaks are: (1) cracks or holes in the casing, (2) plugged drains or vents, etc., (3) corrosion of the threads on plugs or pipe nipples, (4) not enough thread engagement, and (5) defective seals, packings or a broken shaft.[9]

Making The Inspection. Review the pump's parts carefully to be sure that you understand all of the details of construction. Across the table discussions with manufacturer's representatives will be very valuable in determining the best inspection methods.

Step one: Examine the foundation, base plate and anchor posts to see if regrouting and/or bolt replacement or repair is necessary.

Detailed inspection: Disassemble the pump and inspect the casing the same as if it were a pressure vessel. Check its thickness. Inspect the flanges for cracks and the gasket surfaces for good finish. Check the clearance between the wearing rings. A rule of thumb for pumps handling cool liquids is a diametral clearance of 0.010 inch for each inch of wearing ring diameter.[9]

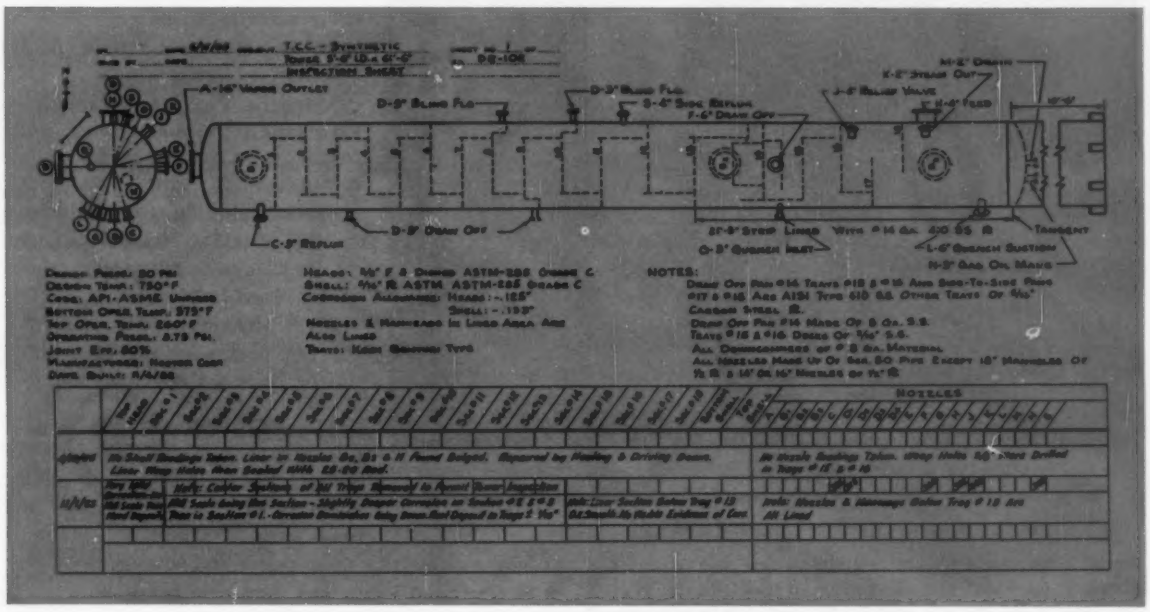
If the pump operates with soft packing, the shaft sleeves should be inspected closely for excessive wear.

If mechanical seals are used, each part must be inspected and no deviation from a perfect condition can be tolerated. The finish of the shaft sleeve under the mechanical seal should be nearly perfect.

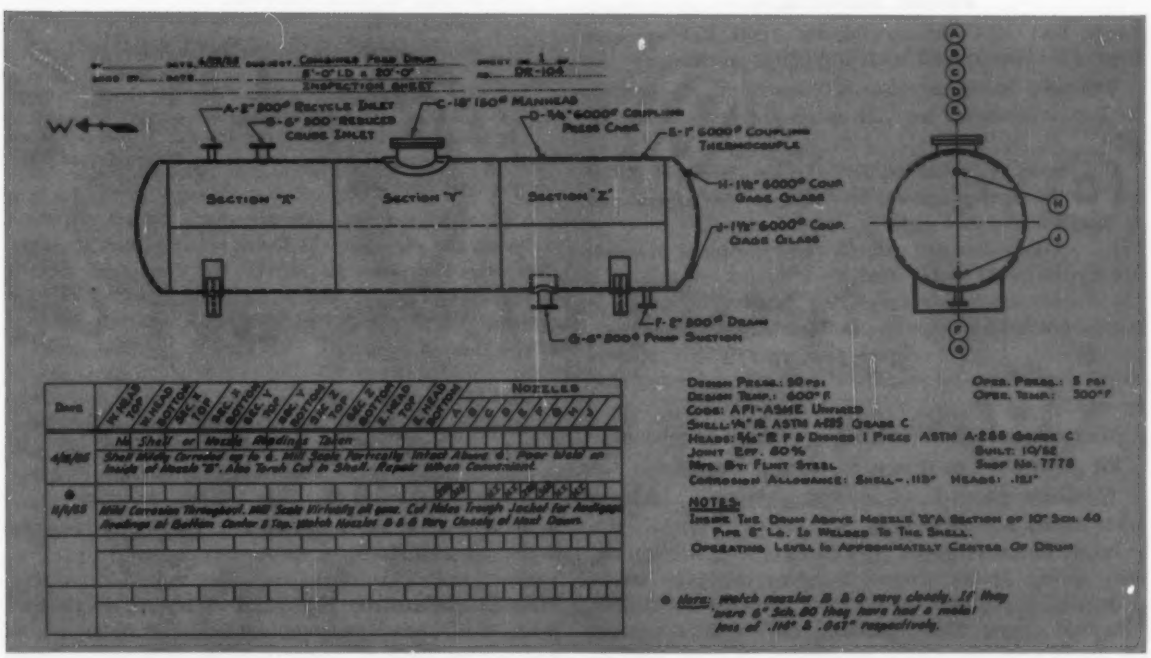
If the bearings feel rough when turned, it may indicate a faulty bearing. Check sleeve bearings for wear and pulling of babbitt.

Watch for vibration in a centrifugal pump. If the impeller is statically balanced, no vibration will be encountered. Shaft vibration not exceeding 0.002 inch is permissible for a new or repaired pump when installed on its foundation.

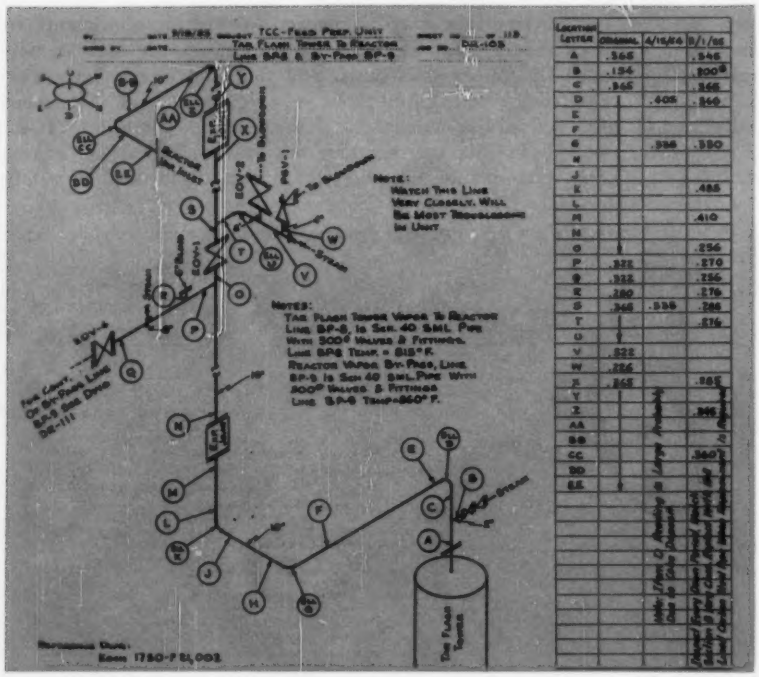
Reciprocating Pumps. These pumps of the direct acting type may be checked for operating efficiency by the slip test. If the steam valve is slowly opened, with the pump shut down and the discharge valve closed, the piston should move very slowly, if at all. The speed of piston movement indicates the condition of the internal parts. Leaking suction valves and/or leaking piston rings will allow the piston to move rapidly, indi-



Fractionator inspection sheet shows thickness readings in tabular form.



Accumulator inspection sheet indicates shell thickness and operating data.



Piping inspection sheet gives original pipe thickness and inspected thickness.

cating excessive slip. Do not make this test without a pressure gage on the discharge of the pump. Watch this gage and do not allow the pressure to go above the rated pump pressure.

PIPING INSPECTION

Tools. Sun Oil Company's Marcus Hook Refinery uses these following special tools for piping inspection:[10]

Ball-peen hammers: 16-ounce size for small pipe up to 1 inch diameter and 24-ounce for large diameter pipe.

Calipers: (1) Spring calipers: An assortment of inside and outside spring nut calipers that will suit the range of pipe sizes within a particular refinery.
(2) Lock-joint transfer calipers: an assortment to measure the inside of worn areas, over flanges, etc.
(3) Direct reading calipers: an instrument which is trigger-operated to open and close the measuring jaws.
(4) Scissors gages: calipers that operate like scissors to measure the wear in rolls of box ells and other line fittings.

Micrometers: Check internal or external distortions.

Pit gage: Used to determine pit depth on pipe.

Thickness gage: Used to find pipe wall thickness when a test hole is drilled.

Inside diameter gages: (1) Electronic: Twelve movable spring loaded fingers measure the pipe inside diameter.
(2) Pole gages: Three pronged devices held against the ID of a pipe by spring tension.
(3) Mechanical ID gage: Similar to electronic gage with each finger recording maximum ID on a graduated taper chart.

Magnifying Glass: Used for visual inspection.

Ultrasonic Gage: Used for thickness testing but seldom relied on exclusively.

Mirror: Used to inspect otherwise inaccessible locations.

Flashlights: A three-cell pocket type and a large spot light.

Magnetic Particle Examination Equipment: Applies iron powder coating to examine pipe for minute cracks.

Special miscellaneous equipment:
(1) Portable X-ray equipment
(2) Portable Laboratory Hardness Indicators
(3) Microscopic equipment
(4) Equipment to spot check pipe for alloy content.

Inspection Methods. Hammer-testing is the most widely used inspection technique and a skilled inspector can easily locate thin and weak sections of pipe.

Sun recommends these points for hammer-testing:

- Ells, mitered joints, tees, and pipe bends
- Heat affected areas adjacent to welds
- Nozzles or other connections, such as drain lines
- The bottom of lines on which corrosive condensate may collect or travel.

Pipe may not always ring clear when struck by a hammer. This may be caused by a deposit of coke or scale within the line.

The disadvantage of hammer-testing is that it cannot be done on insulated lines and is an unsatisfactory test for pit-type corrosion.

After thickness readings are made by an ultrasonic tester on the piping in the Delta refinery, thin spots are checked by drilling to verify the readings.[3] Erratic thickness readings probably indicate coking or that schedule 80 pipe was mixed in with schedule 40 pipe at the time of erection.

Visual Inspection. After pipe has been dismantled and thoroughly cleaned by steaming, scraping or by chemical means, the surface should be checked for pits, cracks or blisters, as well as reduction in wall thickness. The pit depth should be measured and added to any over-all general corrosion noted. This establishes the minimum wall thickness remaining.

Pipe Classification. Hydrocarbon piping: High temperature-low pressure pipe, including transfer piping and heavier product piping of crude units and catalytic cracking units, is not generally subject to pit-type cor-

rosion, and a through hammer-testing every 12-18 months has proven to be a safe inspection frequency at Sun's Marcus Hook refinery where corrosive sulfur compounds are not present.[10]

In the vapor lines out of catalytic cracking reactors, there is usually a catalyst carry-over of fines. This results in a corrosion-erosion attack. Check these lines carefully during your next turnaround.

High temperature-high pressure piping includes thermal cracking unit piping between furnace outlets and the inlet to the fractionating tower. Gage the entire length of this line at least once a year.

Low temperature-high pressure piping in charging and product lines of gas recovery plants should be visually inspected and measured. Judicious use of a ball-peen hammer indicates weak or doubtful areas which should be dismantled for complete investigation.

Low temperature-low pressure crude and cracking unit product lines usually require a hammer testing every 3 or 4 years.

Chemical Piping. Hammer-testing of caustic lines once a year is recommended. If repairs are necessary, completely neutralize the caustic before welding.

Sulfuric Acid. Pipe failures occur in the weld and adjacent weld areas, therefore, hammer-tests should indicate weak sections.

Naphthenic Acid. Usually, the pipe is lined with type 304 stainless steel, therefore, visual inspection is necessary to determine the liner condition.

Hydrofluoric Acid. In the acid regeneration section, dismantle and visually inspect and measure the pipe at six month intervals. Hammer-test all lines annually.

Catalysts. These lines fail from erosion and should be examined visually. Dismantle the large lines out of the bottoms of reactors and inspect visually during each turnaround. Hammer-test small catalyst lines when possible. Failures in the small lines may be repaired with clamps temporarily and replaced during the next turnaround.

Service Piping. Water piping is generally run to failure, then it is clamped until it can be permanently repaired. If an underground branch line fails, adjacent sections of the same service life are hammer-tested. Whenever underground lines are exposed, such as for repair of an adjacent line, hammer-test the water line in place.

Steam. Hammer-test the condensate lines annually.

Records. The use of a card index system on critical piping is recommended. A summary of inspection is transcribed to the card for a particular line and these make a complete history file on the troublesome lines.

Analysis of Inspection. In many cases, the wall thickness will be found adequate for another run but replacement should be anticipated on the next turnaround. This decision is based on the corrosion rates observed during inspection.

Sometimes, a change of wall thickness from schedule 40 to schedule 80 pipe may be more economical where corrosion rates are high.

Inspectors may also note that the reduction in line size has caused turbulence and repeated failures.

Miscellaneous Equipment. When Eastern States Petroleum Company's Houston refinery inspects valves by removing them from the line and taking out the bonnet and stem, all parts are first checked visually, then G-gage calipers are used to determine the extent of corrosion.[8] They inspect carefully for corrosion of the valve seat guides and accumulated fouling material under the valve seat.

Relief Valves. Canadian Oil Company's Sarnia refinery checks relief valves to release half way between the design and operating pressures.[7] That is, if the vessel is operating at 200 psi and its design pressure is 250 psi, the relief valve would be set to release at 250 psi then the pressure dropped to 225 psi and the valve is reseated at that point.

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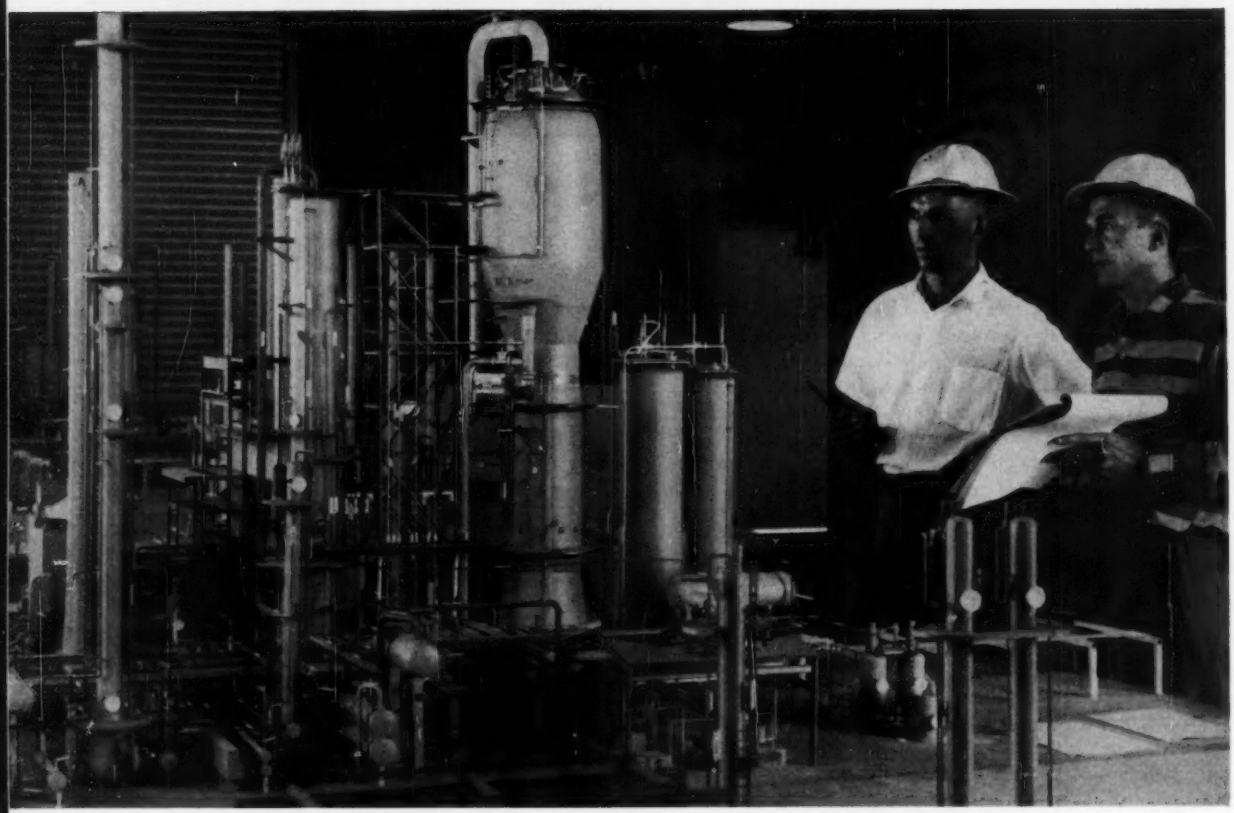
5. Keeping Cost Records

MAINTENANCE is a long-term program. Some of the results of good maintenance take a long time to show up. Management needs good maintenance cost indicators whether their problem is to cut maintenance cost without unduly risking the operation or whether they want to raise the quality of maintenance without creating excessive costs.

Optimum maintenance costs can only be achieved by following a combination of the controls discussed in this chapter. Try them in your plant and watch your cost tumble.

Maintenance Cost Yardsticks. In making a maintenance cost survey for their 1956 API paper, Standard of Ohio authors found that maintenance costs in the plants studied ranged from 3 to 5.5 percent measured



Maintenance cost records require detailed study of your equipment.

in terms of maintenance costs as a percent of capital investment.[1] Individual process units varied between 2 and 7 percent.

The authors also found that one of the simpler ways to index maintenance costs was in terms of cents per barrel of crude. The numbers are easy to remember and ranged from 10 to 25 cents per barrel. However, they were at a loss in explaining the wide range of maintenance costs per barrel of crude because some of the higher costs per barrel refineries apparently were very well maintained. The authors did not comment on the possibility that some of the refineries reporting in their survey may have charged capital work to maintenance costs during the year for tax purposes. This would, of course, partly explain unusually high costs per barrel for some plants.

It was pointed out that even on equal process units such as cat cracking, some plants used many more pieces of equipment for the process than others, therefore their costs would probably be high for this unit.

One thing can be learned from maintenance costs surveys. There seems to be no uniform method of keeping maintenance costs records in the refining, petrochemical and natural gasoline industries. Very few plants agree exactly on the same items that should be charged as maintenance costs. Quite often, for accounting purposes in view of the tax situation, capital expenditures are charged as maintenance costs. When such charges are included in a plant's report on maintenance costs for the year, naturally, that plant's information will show an unusually high charge to the Maintenance Department.

With these differences in mind, PETROLEUM REFINER decided to survey the industry in 1958 to determine maintenance costs for typical units in their plants.[2] The basis of the survey was maintenance costs as a percent of replacement costs. The first step was to ask superintendents to determine the replacement cost of their units. This can be done by referring to a table of replacement factors which upgrades the original cost of the unit to the year in question. By dividing the direct maintenance costs for the year by the replacement value of the unit, a maintenance cost for the unit as a percent of replacement cost may be found. The direct maintenance costs were defined as only productive maintenance costs exclusive of burden or overhead. It was to exclude planning and scheduling, which is overhead, supervisory engineering, corrosion inspection, shops operation and overhead, maintenance foremen, clerical labor in the Maintenance Department, operating labor, power, lubricants, chemicals and depreciation.

Authorities do not agree precisely as to just what the

replacement factor should be; therefore, a composite factor made from the recognized authorities' opinions was used.

The bar graphs illustrate the approximate maintenance costs as determined by this survey, and though they probably do not establish precise costs for the industry, they do establish a trend for costs of the various units included in the survey.

Performance Index. Esso's Bayway refinery has set up three performance indices to compare their refinery with other plants in the Esso family.[3] The first index is called "Over-all Maintenance Department Manpower Utilization." This index simply summarizes the total maintenance workers used per million dollars of plant investment. The second index is called "Over-all Maintenance Manpower Productivity." This index measures the percent of working time to the total maintenance labor time charged. The last performance index is entitled "Maintenance Level Of Refinery."

By letting the plant run down, the first index would show a very low total number of men per million dollars of plant investment. Therefore, the last index was developed to show the level of maintenance in each plant. Esso uses five weighted factors to find this index. These factors include:

1. The amount of overtime worked (a good maintenance level and good planning normally reflects in low overtime)
2. The amount of work backlog (the level of maintenance performance is down if the backlog of work orders increases)
3. The plant appearance (a sloppy looking plant with considerable litter and unsafe conditions indicates that it is poorly maintained)
4. The number of preventatives maintenance inspection backlog items (when vital pieces of equipment are not inspected as scheduled, the indication is that maintenance planning is slipping)
5. Equipment out of service for repairs (by simply counting the total number of equipment pieces out of service for repair at a certain time each month, Esso is able to make a spot appraisal of this factor. Of course, this number would probably not be zero but neither would it include a high number of equipment pieces).

Esso found that its first index varied between a low of 3.5 men per $1 million to a high of around about 5.5 men per $1 million. They also found that this index varied widely between particular units such as fluid catalytic cracking units and crude units. Therefore, by comparing similar individual units, as well as on a plant-wide basis, they were able to get a good idea of what the various plants were doing.

Esso feels that these indices simply and accurately tell both the Plant Maintenance Department and management how efficiently the men and equipment are being used.

Classifying Maintenance Cost. When someone asks for a breakdown of maintenance costs, it suddenly depends on whose doing the asking as to the type of report he will receive. Mansanto Chemical Company has found that its top management generally wants to know what part of their sales dollar is chargeable to maintenance, or what is maintenance as a percent of capital investment, or what percent is maintenance cost per unit of production, or they may simply want the gross costs charged to maintenance.[4]

On the other hand, Monsanto finds that the maintenance superintendent needs considerably more detail than these summary cost reports for management. He needs maintenance costs summarized for specific pieces of equipment so that he can analyze the recommendation of replacing or maintaining the equipment. Perhaps he would want them summarized by equipment type in order that long-range studies could be made for changing certain types of high maintenance equipment. He could possibly want the maintenance cost summarized by each department or unit in the plant for comparative purposes. Excessively high costs on one unit would show up in the report and investigation could then be started to eliminate these costs. He may also want a report summarizing the ratio of material to labor costs in order that he can have an idea of his labor efficiency.

If the maintenance superintendent receives these types of summary cost reports, it will be rare that management will call on him to explain why maintenance costs are out of line.

Cost Distribution. Conoco's Ponca City refinery distributes its Mechanical Division costs by percent as follows:[5]

Capital	15
Maintenance	34
Operating Mechanical Service	7
Mechanical Operations	10
Operating, Cleaning and Service	20
Outside Work	5
Nonwork	9

All of the items listed are subject to work order control except Mechanical Operations which are permanently assigned personnel like operators, truck drivers, tool crib men, etc., and the Nonwork classification which represents absenteeism of all types, including vacations and sickness.

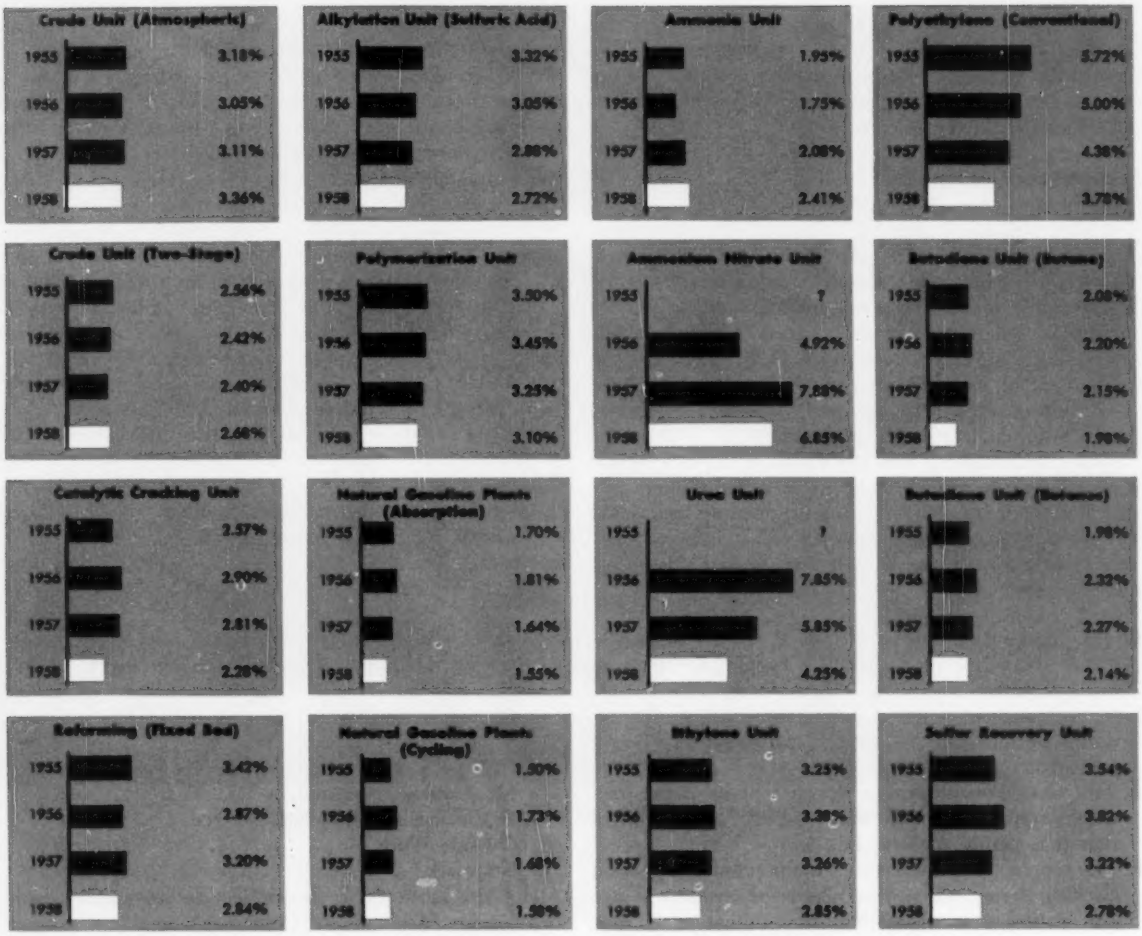
C. C. Carmine, with Tidewater, says that maintenance labor and material costs are approximately 15 to 25 percent of the total direct manufacturing costs. He also says that labor and overhead represent about 70 percent of the total maintenance costs and material costs represent the remaining 30 percent.[6]

COST CONTROL PROGRAMS

Equipment Cost Control. The maintenance supervisor can no longer control maintenance costs by controlling the total labor and material costs by units. Today, he must analyze his costs by specific pieces of equipment, according to Du Pont.[7]

The Du Pont Company has set up a specific equipment cost program that consists of the following details:

- They have adopted the use of an equipment numbering system
- They have set up a good work-order system
- Their cost system has been worked out for rapid collection of cost information on each piece of equipment and for issuing reports on this information
- They have devised a good filing system for their



Graph figures show maintenance costs as percent of replacement costs.

work-order, inspection and overhaul reports for each piece of equipment

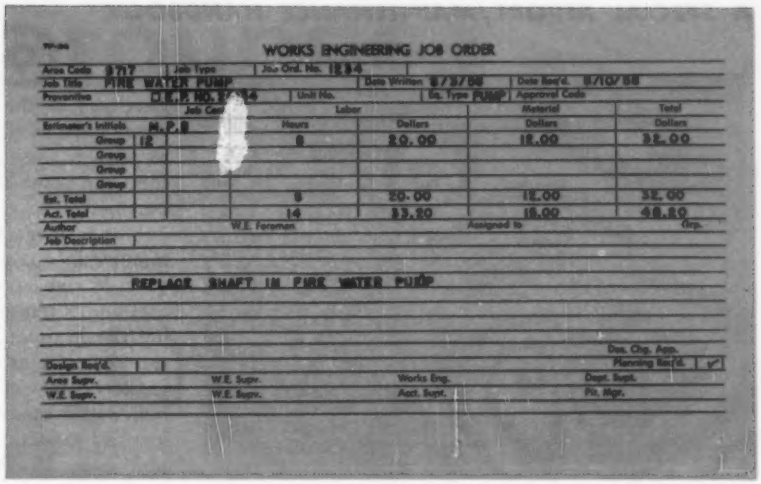
- They have organized the necessary engineering personnel to analyze these reports, make recommendations and carry out the corrective actions that should be done.

The steps in installing the Du Point system were:

1. Setting up pocket notebooks for all maintenance supervisors that contain a description of each piece of equipment and assign equipment numbers for each piece described.
2. Review the work-order procedure to be sure that it is the best way for requesting maintenance work to be done. Du Pont processes their work-orders through the area foreman who checks them for clarity and enters the equipment piece number, which he carries in his pocket notebook, and forwards the work-order to a clerk who assigns a work-order number. Planning and Scheduling then processes the order and a copy is sent to their Tabulating Section, which key punches a card including the appropriate equipment piece number.

   After the job is completed, the foreman fills in a distribution form showing the labor and material used on the job. This form is sent to the Tabulating Section after each craft has completed their job.
3. The Tabulating Section continually collects information on material and labor costs used on each piece of equipment; and when the job is complete, the total costs are summarized and filed.
4. The Tabulating Section issues a report monthly or quarterly as requested by the maintenance superintendent, which shows each piece of equipment, the costs to date that have been spent on this equipment, the maintenance cost per year that is budgeted for the equipment, and a ratio of actual cost to budgeted cost.
5. Du Pont's Cost Control analyzes these reports to determine which costs are excessive, and recommends what can be done to reduce them.

Statistical Analysis. Du Pont has developed a useful technique for determining the pattern of equipment failures. They plot the number of failures on a particular piece of equipment against time on probability paper. An analysis of the plotted graphs shows that the failures fall into three distinct areas, which are classified as "Infant Mortality," "Random Failures," and "Wear-Out." If you have misapplied the equipment, have poor installation or faulty workmanship, the equipment will fail early in its life and is classified as "Infant Mortality." "Random failures" indicate that something is out of control, which may be the process or the preventive maintenance program. "Wear-out" indicates that the equipment has run for its useful life, as expected.



WORKS ENGINEERING JOB ORDER

Area Code 317 | Job Type | Job Ord. No. 1234

Job Title FIRE WATER PUMP | Date Written 8/23/58 | Date Rec'd. 8/10/58

Preventive | E. P. No. 12-14 | Unit No. | Eq. Type PUMP | Approval Code

Estimator's Initials M.P.B	Job Code	Labor Hours	Labor Dollars	Material Dollars	Total Dollars
Group 12		8	20.00	12.00	32.00
Group					
Group					
Group					
Est. Total		8	20.00	12.00	32.00
Act. Total		14	33.20	15.00	48.20

Author | W.E. Foreman | Assigned to | Grp.

Job Description

REPLACE SHAFT IN FIRE WATER PUMP

Design Rec'd. | Des. Chg. Appr. | Planning Rec'd. ✓

Area Supv. | W.E. Supv. | Works Eng. | Dept. Supt.

W.E. Supv. | W.E. Supv. | Asst. Supt. | Pl. Mgr.

Work order form is means of communicating the requested maintenance work.

By preparing graphs for each piece of equipment and correcting for infant mortality and random failures, the equipment should run for its useful life with a low probability of early failure.

Dow Chemical makes a good point in stating that it is very important in establishing a cost control program to be sure that the system will pay for itself.[8] It would certainly be a waste of money if the cost control program actually used more dollars than the Maintenance Department saved.

Dow says that their system of time standards works so well that for each dollar they spend on the program, three dollars in maintenance costs are saved. In the Dow system, the maintenance foreman determines the work required and makes a list of materials and work instructions. The number of workers required is estimated, along with a standard allowable time for the job. Each worker's time is recorded on a job-time card. The total actual hours to complete the job are then compared with the estimated standard time.

One company found by establishing committees to study maintenance costs, at the insistence of the plant manager, that there were several obvious items of high cost which had been overlooked.[9] For example, they found that the mechanics were using a 60 cent per gallon hydraulic oil for ordinary lubrication when a 30 cent per gallon oil was satisfactory. They also found that one piece of equipment required a bearing change every week but that by changing the lubricant, the life was extended to 25 weeks. If this company had been analyzing their equipment history cards, these high cost items would not have occurred and the plant manager would probably not be screaming that maintenance costs were too high.

Reports. Maintenance supervisors often have so little cost information available that they have little real knowledge of why or how their costs are out of line, or actually whether they are really excessive or not. Therefore, their usual recourse is to make some sort of explanation to the management or lay off enough maintenance men to satisfy management that maintenance costs will be down.

The maintenance supervisor can get a better picture of his costs by following these suggestions:[10]

Weekly Time Reports. The supervisor should maintain weekly labor hours of each maintenance crew, reported by daily totals, and all overtime hours shown. With this information, the maintenance supervisor can check to see if (1) the total time going to the Accounting Department is correct, (2) check on the reason for all overtime hours while the work is still fresh in his mind and (3) note on this form any large number of repair hours for a particular job.

Weekly Material Reports. The maintenance supervisor can request that the Accounting Department furnish a weekly list of repair materials ordered. He can then check on any large or unusual charges and investigate the reasons that the Accounting Department has made these charges, while the details are still in mind.

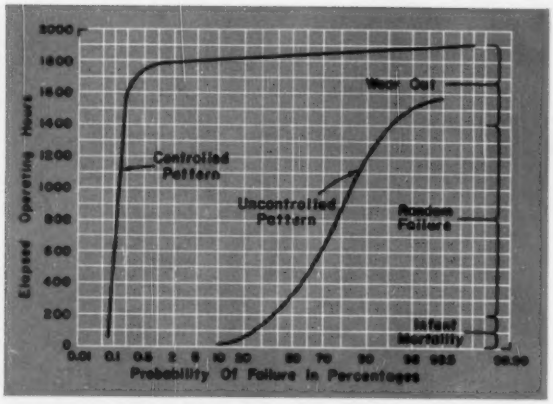
The supervisor is now practicing cost control by checking on items for which his department is charged and making sure that they are correct and that he knows what the charges are for. If charges for a particular month are high, the supervisor can easily explain to management what caused these costs.

Job Costs. Real cost control is gained by accumulating the repair labor and material charges against each work order as it is being performed. The Accounting Department will seldom keep these records, so it's up to the maintenance supervisor to require his clerk to maintain such a system.

By checking on the daily summary of work-orders, the maintenance supervisor can see at a glance the total labor hours and material charges against each job, while it is in progress, and can take steps to limit or control the costs on any one job.

This "in process" type of cost control is his best weapon in preventing large jobs from running over estimates and getting out of hand costwise.

Equipment Costs. Another value of these accumulated labor and material charges is that they can be entered on a cost card for each piece of plant equipment and at the end of each six-months period, the



Equipment failures fall into three distinct areas: infant mortality, random failure and wear-out.

total cost for maintaining a unit can be easily found.

With such information available, the maintenance superintendent can easily find out which equipment is too costly to maintain and whether it should be modified or recommend process changes to reduce maintenance costs.

Clerks. Some plants complain that the cost of this accounting procedure is too expensive. One clerk can handle each 100 men in the Maintenance Department easily, entering all of the job costs on equipment cost cards and still have time left to order maintenance materials and perform other odd jobs. The answer to the question of expensive, maintenance clerk costs is that the savings which can be realized through the use of a maintenance cost accounting system will easily offset the clerk's salary and overhead expenses.

Foremen-Key Cost Cutters. The maintenance foreman or front line supervisor is more likely to become highly cost conscious if he knows that the money he spends is being closely watched by the maintenance superintendent. Also, he will more carefully check on his labor costs if the maintenance superintendent is periodically sampling the use of maintenance labor throughout the plant. This sampling technique can be simply a once-a-day walk through the plant observing the number of people working, idle, or in transit.

It will not take many samplings to determine if a foreman is not utilizing his men at their peak output.

The Maintenance Budget. There is a considerable difference of opinion in the industry on the use of maintenance budgets. Many feel that maintenance costs are too intangible to establish a good budget and that one good scheduled breakdown could wreck the budget. However, others feel that by keeping records and taking into consideration all of the services the Maintenance Department performs, a budget can be realistically set up.

Many of these same intangible costs are faced every day by contractors bidding on jobs. Maintenance is growing up and is becoming big business in itself. Therefore, maintenance supervisors are simply going to have to face the same problems that production supervisors have faced for years and quit thinking that maintenance is something that just must be done and that they can leave the paper work to the Accounting Department.

Management needs a fairly accurate idea of the maintenance costs that can be expected for the coming year. If you have not developed a maintenance budget and one is requested, a good place to start is by dividing the Maintenance Department into as many activities or units as possible.[8] For instance, a budget for janitorial services should be relatively easy for office buildings because of the fixed cost nature of the services. By working on each unit, one at a time, and possibly using Du Pont's equipment system, the plant can be divided in a relatively short time for budget purposes.

Here are the points that one author says must be considered in setting up a good maintenance budget:[11]

- Maintenance records and supervision
- The preventive maintenance program
- Outside service contracts
- Any revamping programs
- Maintenance research and development
- Maintenance training programs
- Shop facilities
- Area facilities
- Stores spare parts account
- Engineering and drafting time chargeable to maintenance
- Transportation
- Communication
- Participation in professional activities
- Inter-plant visits and conferences
- Proposed increase or decrease in the maintenance labor force.

Faced with mounting maintenance costs, Du Pont started an 18-point program to reduce cost in 1957. It has been reported that their labor effectiveness has improved as much as 30 percent in some of their plants. Maintenance savings up to 20 percent have resulted.[12]

All of the elements of Du Pont's 18-point program have been covered in this handbook. This, of course, is dramatic proof that these principles work to cut costs.

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6. Turnarounds

BEFORE THE World War II manpower shortage, men were generally hired for major turnarounds and laid off as soon as the unit was back onstream. During the war, when the emphasis was on production, the bars were down and practically all applicants were hired. After the shutdown, they were not laid off and the general practice of a fixed permanent crew came into being. Today, the advantages of a permanent crew are recognized for good employe morale which results from job security.

Turnaround Organization. Phillips Petroleum feels that a temporary organization should be set up in most medium and small-sized refineries for the duration of the turnaround with one man responsible for the organization.[1] Usually, the turnaround supervisor in Phillips' plants is the mechanical or maintenance superintendent or one of their assistants. For large refineries, Phillips suggests that the turnaround organization could be a permanent setup.

The organization and the process unit involved should both be divided into workable-size elements. For example, a fluid cat cracker can be divided into 12 to 14 areas. The catalyst structure will require about 6 or 7 areas and the fractionation-gas recovery section the remainder.

Phillips assigns a front line supervisor to one or more areas and it is his job to complete all of the work in these areas. By dividing the work and the organization into small areas, the scope of work for each front line supervisor is held to a minimum.

Who's Responsible? The responsibility for production, quantity and quality rests with the Manufacturing and Operating departments, says Gulf Oil.[2] Therefore, in determining what work will be done on a turnaround, these departments should define the scope of work. Since they are responsible for the mechanical condition of the unit when it is put on stream, they should initiate work requests for the turnaround. For example, Gulf says that whether or not a tube bundle is pulled and cleaned or retubed, or a tower section opened, is the responsibility of the Manufacturing and Operating departments.

Gulf points out that turnarounds must be planned sufficiently in advance of the shutdown so that major pieces of equipment and material can be ordered and time made available for a thorough study of the job by field supervisors.

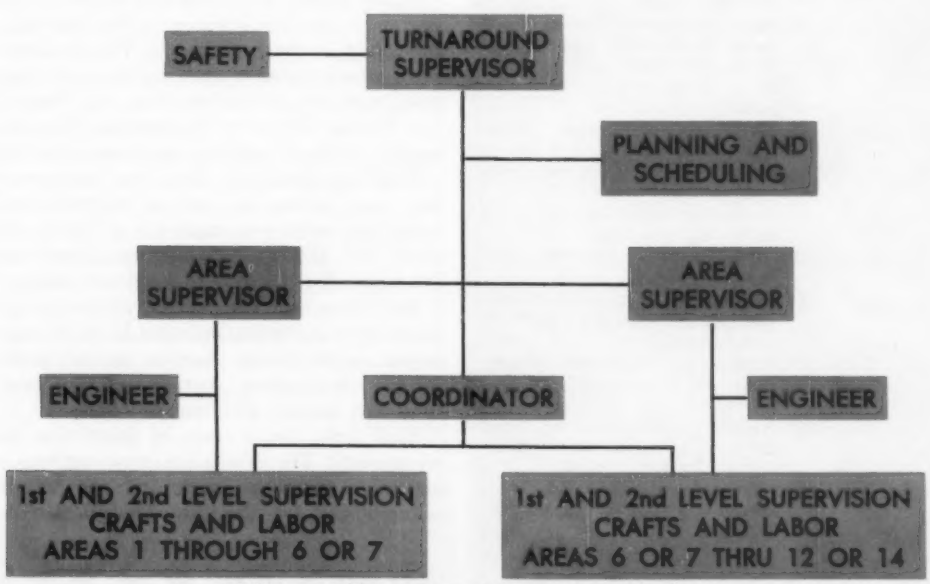
Turnaround Planning. Before Sinclair's Wyoming refinery planned its turnarounds, it wasn't unusual to have two or three unit failures a year. Since turnaround planning was started, Sinclair now has a reasonable assurance that they can operate continuously for a year without a unit shutdown.[3]

Good turnaround planning helps the plant's safety program. For instance, Sinclair's Safety Department states that its safety practices during the turnarounds is the best effort of the year.

Sinclair holds a pre-planning meeting just as soon as inspection and maintenance reports are available from the last turnaround. This is a management meeting and from this review, a forecast is made of equipment which will need major attention next year.

Throughout the year, notes are kept on all items requiring work during the next turnaround. This information is kept by the unit foreman who sends copies to the Mechanical Department.

Thirty days before the turnaround, the outline that


SAFETY
TURNAROUND SUPERVISOR
PLANNING AND SCHEDULING
AREA SUPERVISOR
AREA SUPERVISOR
ENGINEER
COORDINATOR
ENGINEER
1st AND 2nd LEVEL SUPERVISION CRAFTS AND LABOR AREAS 1 THROUGH 6 OR 7
1st AND 2nd LEVEL SUPERVISION CRAFTS AND LABOR AREAS 6 OR 7 THRU 12 OR 14

Phillips uses this temporary turnaround organization.

ETHYLENE PLANT NO. 1

DOWN 2-5-55

REPAIRS

PIPEFITTERS DISTILLATION (GROUND) ZONE

Operator	Mechanic	
_____	_____	1. Unhead the following vessels and towers: (a) DA-1A (i) FA-63 (b) DA-1B (j) FA-65 (c) DA-2 (k) Instrument air receiver (d) DA-3 (e) DA-4 (l) (f) FA-7A (m) (g) FA-7B (n) (h) FA-60 (o)
_____	_____	2. Replace suction and discharge valves on GA-5AS.
_____	_____	3. Install 3" vent on convertors—FA-2A, FA-2B and FA-2C.
_____	_____	4. Repair air connections on LC-9.
_____	_____	5. Install 2" block valve in propane to coil in FA-103 and FA-104.
_____	_____	6. Install valves in process lines and 2" connections to and from EA-6.
_____	_____	7. Repair steam leak on GA-1s.
_____	_____	8. Repair steam leak on 225# header near SE control room.
_____	_____	9. Repair steam leak on GA-2S bleeder.
_____	_____	10. Repack or replace ½" 225# steam valve on tracer line at east side of control room.
_____	_____	11. Replace 1" bleed on discharge of GA-2.
_____	_____	12. Repack steam throttle valves on: (a) GA-1S (d) GA-5AS (b) GA-2S (e) GA-5BS (c) GA-4S
_____	_____	13. Repair steam leak on 125# drop at 1st outlet north of control room.
_____	_____	14. Replace 1" valve in steam bleed from GA-5BS.
_____	_____	15. Repair traps in tracer steam line at DA-4.
_____	_____	16. Replace bleeder on GA-50 and 50S suction lines with stainless.
_____	_____	17. Replace 3" 150# condensate block valve on EA-18.
_____	_____	18. Install new gaskets in conv. regen. lines. Use flexitallic gaskets.
_____	_____	19. Repair 1½" steam valve on safety steam header at E. side of switch-house.
_____	_____	20. Replace ¾" nipple and valve on tail gas to drier line (directly above west end of control room) with stainless.
_____	_____	21. Re-insulate meter connections on lower trap tray reflux.
_____	_____	22. Clean and repack methanol valves in lines to DA-4.
_____	_____	23. Replace ¾" nipple and bleeder valve on line from DA-4 to FA-60 with stainless.
_____	_____	24. Replace ¾" nipple and bleeder valve on line from DA-3 to EA-16.
_____	_____	25. Necessary pipework to load ethylene in trucks. AFE-A-3771-26.
_____	_____	26. Necessary pipework to install new ethane line from #2 Unit. AFE-3556-990.
_____	_____	27. Necessary pipework to change desiccant in driers.

Gulf's work list (at left) has space for operator and mechanic "ok" checkoff.

has been accumulating during the year is reviewed, brought up-to-date and turned over to the Mechanical Department. Work lists are prepared for each unit and then subdivided for individual jobs. This is where operators can help. They play a big part in Sinclair's planning by evaluating jobs to be done and suggesting which are the most important.

Texaco's Test and Inspection Department plans its turnarounds and divides all work into (1) routine work and (2) special work.[4] Any refinery group interested in the unit turnaround may submit work requests in either of these categories. A special form for these work requests must be received by the Inspection Department not later than two weeks before the shutdown date.

The Manufacturing Division prepares a list showing equipment to be cleaned, repaired, etc. from an operating standpoint and also prepares a shutdown schedule showing the blinds with their location, exact time of installation and other work to prepare the unit for shutdown.

The Inspection Department list shows what is to be opened for inspection and any special repairs known beforehand. The Engineering Department issues any drawings for new construction or revisions to be made during the turnaround.

Detailed planning at Texaco may start six months before the shutdown date. However, some jobs may not be known until the unit is inspected. These may be planned on the job within a few hours and with a minimum of paper work.

Texaco calls special work "control jobs." These are jobs that must be accomplished during the turnaround and may in fact overshadow all other phases of work on the unit. An example would be necessary exchanger repairs.

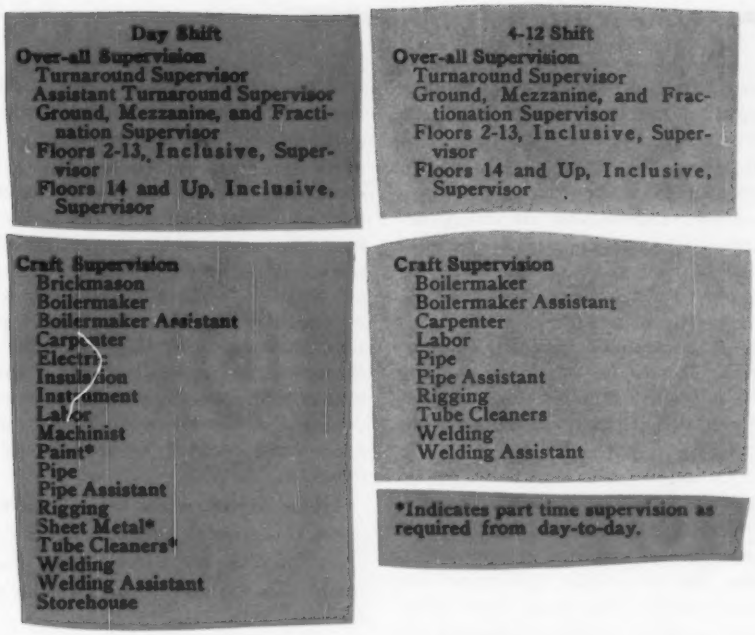
A meeting of the inspector, craft foremen and interested engineers works out the details of these control jobs. Each phase of the job is considered and man-hour requirements are estimated. A detailed plan for the control job is essential because it is the key to the turnaround being finished on schedule.

About a week before the unit shutdown date, Texaco's test and inspection engineer calls a meeting of everyone interested in the turnaround. This includes craft foremen, safety foremen, material foreman, operating foreman, and representatives from the Inspection, Power and Process Engineers Departments. The plans are thoroughly reviewed and any questions resolved.

Shell Oil Company feels that turnaround planning may start when the unit is designed because that's when the decision is made for a 3 to 5 percent downtime.[5] This allows the maintenance superintendent about 2-3 weeks for the unit to be down during the year.

Shell says that the controlling factor in turnaround planning is at the management level. Management must encourage long range planning and act firmly to authorize spending money, cutting red tape and discourage those last minute additions or changes.

Shell feels that a team of three men should run a turnaround. The first is the area engineer, who knows his unit's operation inside and out and is given the responsibility for the turaround details on his unit.



Humble's cat cracker turnaround supervisory roster.

The second man is the planning coordinator, who works full time planning manpower loads. The third man Shell recommends is a non-technical supervisor called a "zone supervisor." He specializes in what the crafts can do, the foremen's abilities, etc. In other words, he is the labor expert. To sum up Shell's recommendations, they suggest an engineer, a labor expert, and a planner and scheduler.

Turnaround Planners. Humble uses a turnaround planner from its Central Planning Group. He plans all turnarounds so that it will be completed in the scheduled time, checks on materials and engineering services, checks with shops to see that they can handle the work and works with the zone supervisor during the turnaround period.[6]

Humble works their turnaround planner during the actual turnaround by having him responsible for obtaining drawings, details, materials, etc. for any jobs not planned before the shutdown.

Tidewater's Project Planning Office makes a master turnaround schedule for all major processing units, a year in advance.[7] This schedule is the result of talks with the Operating, Inspection and Maintenance departments on the availability of manpower.

Tidewater uses two planners who plan between 35 and 40 shutdowns per year. These range in lengths of 3 to 30 calendar days and involve 2,000 to 20,000 man-hours except the fluid catalytic cracking unit which may require as many as 60,000 man-hours.

Tidewater says that it takes at least four weeks to plan a shutdown. This is the time between the preliminary shutdown meeting at which work lists are reviewed and the first day of the actual shutdown. Three of the four weeks are devoted to planning and one week to briefing the shutdown personnel.

The central planning group at Esso Bayway prepares turnaround schedules and revises them periodically to reflect major changes in timing or scope of the work to be done.[8] The region planner makes a sequence plan for jobs including an estimate of manpower required by crafts and notes the necessary mobile equipment. Two months prior to the actual shutdown, the planner works from a recommended list of repairs compiled by the Process and Engineering sections concerning the unit. The total job is broken down into steps and manpower estimates applied to each. It is very difficult to accurately forecast the conditions of towers and vessels before they are opened at the start of the shutdown. But Bayway reports that the use of departmental records will give the planner a high degree of occuracy in making manpower estimates.

Pre-Shutdown Meeting. To provide an opportunity to acquaint the key foreman with the work to be done, General Petroleum holds a meeting prior to a scheduled major shutdown.[9] At this meeting, the work to be accomplished is reviewed, questions are answered, and agreement is reached on many possible differences which might otherwise arise while the work is in progress. These meetings, which ordinarily last from one to two hours, improve the coordination of the work.

Job Sequence. Practically all refineries use some sort of form which lists the sequence of jobs to be done during the turnaround. Gulf's Port Arthur refinery calls these "rough work lists" which are set up about two weeks before the turnaround. These list the equipment and work to be done plus the crafts involved. Space is provided on the Gulf list for an "ok" checkoff by operators and mechanics as each item is completed. Any jobs that come up during the turnaround are simply added, in order, to the work list.

Scheduling Turnarounds. Gulf's Port Arthur refinery makes up quarterly schedules for cleaning and repairing major units, each month.[10] This monthly revision

allows Gulf to make changes in the long range forecast because of operating requirements or other unforeseen circumstances.

Both the Operating and Maintenance departments review these quarterly schedules weekly and make suggestions for the monthly re-scheduling. If emergency work piles up a large backlog, some units scheduled for shutdown may be postponed to take care of the backlog.

The maximum extension of operating time for a unit is 10 percent above the normally scheduled operating hours. If something has to be re-scheduled, Gulf prefers to extend the operating hours of its low pressure units rather than the high pressure units on the turnaround schedule.

Gulf feels that the optimum time between scheduled turnarounds of major units should be one week.

Yearly Schedule. Making a turnaround schedule a year in advance is easy unless you run into some unknown factors during the year that will upset the schedule. The first step in setting the turnaround interval is to find out how much corrosion is affecting the unit.[11] If the corrosion is retarded or can be inhibited, the interval can be extended.

Conoco's Ponca City refinery is trying to reduce short runs to the point that yearly turnarounds can be scheduled for all units.

The next step in scheduling a turnaround is to determine the work force available and to balance this load between process units. Usually, annual inspections can be advanced or postponed about two months.

Conoco's chief inspector makes the initial annual turnaround schedule which is then circulated to all departments for comments and suggested revisions. Emergency shutdowns, changes in market conditions and a change in corrosion conditions all contribute to revising the turnaround schedule during the year.

Unless all turnaround work is carefully scheduled, difficulties are bound to arise during the turnaround. Men and materials may not be adequate and postponements will be requested. Along with the turnaround schedule, the Mechanical Department must also take into account regular maintenance work and small emergency jobs.

The shutdown schedule at General Petroleum is arranged so that, as far as possible, there is at least one week without shutdown work between all major unit turnarounds. This permits the maintenance crew to catch up on the backlog of running maintenance work which accumulates during weeks of major shutdown.

The shutdown schedule is prepared approximately three months before the end of the year, for the coming year. It is revised quarterly and more often if conditions dictate. The shutdown work load is purposely made light for the third quarter because of vacations and the summer gasoline demand when most units are in operation.

General Petroleum's schedule is also used for the preparation of product supply statements. It serves as a guide to determine when repair and replacement parts will be needed and also when alterations and other items of new work should be ready for tying in.

Additional jobs which turn up during the course of a shutdown are covered by a separate shutdown work order written on the job by the inspection engineer who must clear all major items with the area engineer. All work which is performed according to the work outline or shutdown work order must be signed off first as "ok" to close then as "ok" to operate, by the inspection engineer, the assistant maintenance superintendent and the unit stillman. Following the shutdown, an inspection report is written by the inspection engineer who summarizes the work that was done during the shutdown and lists recommendations for spare parts or work to be done on some future shutdown.

Minor Turnarounds. On smaller units, Gulf does not use a turnaround foreman. Instead, they use the zone craft foreman for carrying out this work and these small units are used to balance the over-all turnaround schedule.

Repetitive Work. Atlantic schedules repetitive turnaround work in four sections: (1) known work that is to be done, (2) inspection work estimated from history records, (3) the operator's list estimated from history on the unit and (4) normal contingency work estimated from past turnaround records.[12]

Work Outlines. Two or three weeks before a unit is to be shut down, General Petroleum writes a work outline on which all work to be performed is listed under suitable headings. This is done by the inspection engineer. As soon as the final work outline has been issued and it is known which items of equipment will be worked on, a detailed shutdown procedure for the stillmen to follow in shutting-down, blinding-off, and vapor-freeing the unit is prepared by the area engineer. These shutdown procedures are carefully worked out with the thought of releasing the various items of equipment for gas-freeing and opening as quickly and as safely as possible.

The work outline used by National Co-operative Refinery Association which shows the turnaround work assignments is posted in the control room for each unit during the scheduled shutdown.[13] The control room then becomes the main point for checking on the work progress. As each job is completed, a notation is made on the work outline and a continuous picture of the progress can be seen. This is the same as a work list used by other refineries and simply shows a step by step procedure to be followed. As each step is completed, the inspector, the maintenance superintendent, and the craft foreman initial each job completed.

Scheduling Manpower. Gulf uses about 75 percent of the maintenance force on the day shift during a turnaround and the remainder on a second shift. Some jobs, like tower lining are worked on the third shift.

Lion Oil Company schedules turnaround work for one 10-hour shift per day, except for special work

where welders and boilermakers are used on two shifts during the last 10 days of the turnaround.[14]

Texaco uses a weekly and daily manpower schedule for regular maintenance work and this same plan is followed for turnarounds. The week before the shutdown, the test and inspection engineer gives a schedule to the planning and scheduling supervisor. This schedule outlines the manpower requirements for each shift during the first week of the turnaround. The Planning and Scheduling Department co-ordinates this manpower request with other maintenance demands in the plant and issues a weekly schedule for each craft and each shift. Daily schedules are issued during the week to provide for any changes that may come up during the turnaround. Twenty percent of each craft's strength is withheld from the weekly schedule for flexibility.

Work is done on a 3-shift basis at General Petroleum's Torrance refinery. The split is made for one-half of the craftsmen to work the day shift, however, the daylight superintendent is responsible for the over-all direction of the turnaround.

Phillips concentrates its manpower on the day shift and only bottleneck jobs are done at night.

Phillips uses a coordinator to keep materials, tools, mobile equipment, transportation, etc., flowing to the mechanics.

Service Factor Committee. Humble's Baytown refinery has a group called the "Service Factor Committee." This group was formed to improve the service factor on each unit in the refinery. Representatives from the Operating Department, Technical Service, Maintenance and Design Engineering, the Mechanical Division, and the turnaround planner all are on this committee. They meet periodically and try to discuss problems that would lower the service factor on each unit.

The committee is active in reviewing the various work schedules proposed for a turnaround. Humble feels that its units' service factors have been materially increased by the suggestions made through this committee and has figures to prove it.

Shutdown. Sinclair starts its units down over a weekend. A few pipefitters are brought in on Sunday to start blinding and opening the vessels. This allows the work force to start right in on Monday morning since most of the units will be cool enough to work on. Sinclair also changes their work day from eight to nine hours and include Saturdays and Sundays on bottleneck jobs during the turnaround.

Phillips calls a daily committee meeting consisting of key management personnel during the actual turnaround. Any additional work items or unexpected circumstances are discussed in this hour meeting. Additional work hours are analyzed prior to the meeting for manpower requirements, craft sequence and material required. Phillips can estimate major unit turnaround requirements within 5-10 percent: the larger the job, the more accurate the estimate.

Phillips uses the Management Committee to hand down immediate decisions, especially those affecting the turnaround efficiency and completion. Overtime is a high cost item and is authorized by the Management Committee only after the economics have been analyzed.

At the start of the work, the Safety Department rechecks the blind list for accuracy. Any trouble spots from a safety viewpoint are corrected.

In some refineries, safety and inspection work is done under a single department. Phillips divides these functions and schedules each the same as other jobs on the turnaround.

During Atlantic's turnarounds, special attention is given those items which are expected to be replaced the following year. Detailed measurements are made along with sketches and any improvements noted for attention.

Equipment Replacement. Sinclair feels that equipment such as exchanger bundles, slide valves, large valves, piping sections, etc., should be installed as complete units whenever possible. In other words, they recommend carrying spare units for all equipment that have high wear rates or other operating problems. They replace this equipment every other year and repair it between turnarounds.

Turnaround Materials. Humble uses four-foot square boxes to store and issue material used in turnarounds. These boxes are made on standard pallets and are transported by straddle trucks to the unit. Humble estimates that as much as 40 percent of the material used on the turnaround is issued from these boxes at the unit. Special material comes directly from the storehouse when needed.

Services. Humble has installed many new electrical outlets for welding machines since their cat crackers were constructed.[15] Turnaround experience indicated new locations and temporary welding outlets are installed if necessary.

Humble has also installed a piping unit for oxygen used in cutting operations. They have run a header from the ground to the top of each unit and put two outlets on each floor. Oxygen trailers are parked near the unit and tied into the distribution system during the turnaround. Humble uses as many as five trailer loads of oxygen at 11,000 cubic feet each, during a turnaround. They save over 30 cents per hundred cubic feet by buying bulk oxygen instead of bottled oxygen. They also save in man-hours required to move the bottles up and down the structure.

Mobile Tool Room. Lion reports that they have saved 15 to 18 percent of the manpower required for a turnaround by using a mobile tool room instead of working out of a central tool room in the shop area. This mobile tool room also saves them 60 percent in trucking costs chargeable to the turnaround and 30 percent in tool requirements.

Lion transfers all of the hand and power tools required for the turnaround to their 8 x 20 foot mobile tool rooms which are moved to the unit the day before it is scheduled for a shutdown.

Turnaround Records. Texaco's Inspection Department keeps a record book of the loose-leaf variety for each unit. Total manpower used, details of work on exchangers, vessels, piping, mechanical and other details for the unit are recorded. For planning future turnarounds, these records are invaluable.

After the Turnaround. Humble's Mechanical Division calls for a meeting after each turnaround, including maintenance supervisors, engineers, stores, operators and others involved in the turnaround. The idea is to

check on any problems that can be ironed out next year while it is still fresh on their minds.

Four weeks after the turnaround, Humble's maintenance engineers write a list of repair problems for the next turnaround.

Revamps During Turnaround. Refiners have found that a turnaround is an excellent time to make major changes for revamp of the unit. The major difference with this operation and ordinary construction is that time is working against the construction crew every minute the unit is down. Cosden Petroleum Corporation licked this problem during a cat cracker revamp job.[16] They prefabricated the piping and marked it according to line size and piece number before the turnaround to make assembly easy and fast. They also used a color coding system on the existing pipe which was involved in any changes. The piping to be removed was painted with a yellow stripe. If part of the pipe was to be removed, that part was painted with a yellow stripe and its terminal points were painted with a green stripe. This same system was used on pumps and exchangers to be removed or relocated.

Most of the new foundations for the revised cat cracker were poured ahead of the turnaround. In relocating existing equipment, center lines were marked on new foundations before the turnaround.

All of the new steel structures required for the job were made in the welding shop and preassembled at the site.

Cosden reports that 55 percent of the man-hours chargeable to revamping this cat cracker were made before the unit came offstream.

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7. The Instrument Department

DU PONT SAYS that instrument maintenance costs are determined by the following factors:[1]

- The amount of maintenance consideration given the instrument by the manufacturer who designs it.
- The amount of maintenance know-how that the plant has and the amount of test and calibration equipment that is required to maintain a particular instrument.
- How much education the plant must provide or is required of instrument mechanics to perform the maintenance.
- How many replacement parts are required for a particular instrument.

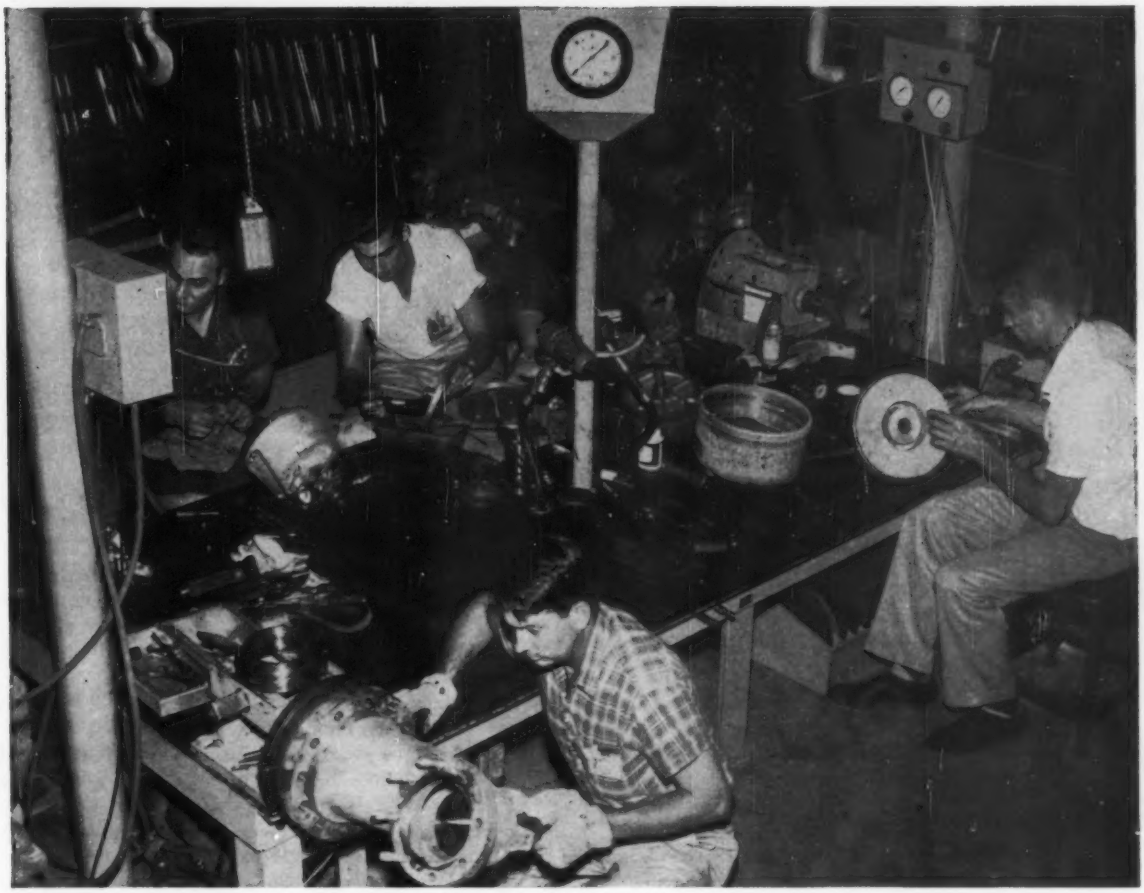
Du Pont feels that to reduce maintenance costs, instruments must be designed from a maintenance standpoint that will help the plant maintain the following levels of maintenance:

First-Level Maintenance. This includes scheduled and non-scheduled daily, weekly, monthly, etc., visual inspection, adjustments and minor replacements.

This level of maintenance can be accomplished by requiring that instruments be designed so that the equipment can be repaired in place. Major component parts and assemblies should be designed for easy accessibility and for ease of replacement. The instrument should be designed so that small parts and small subassemblies can be easily replaced instead of making it necessary to replace larger assemblies. The instrument should be designed with a minimum number of screws, nuts and bolts and all of these should be of standard sizes. Complete maintenance manuals including spare parts lists and prices should be available to the plant at least a month before the equipment arrives. Replacement parts should be available to the plant when the equipment is delivered.

Second-Level Maintenance. This should include scheduled and non-scheduled performance testing, calibration checking, and replacement of assemblies if required. This can be accomplished by providing front of board testing, checking and calibration means without interrupting the services. Or, at least, only a brief shutdown should be required if a replacement must be made.

Third-Level Maintenance. This level involves the repair of instrument assemblies when necessary. It may be accomplished at the lowest costs if the instrument assemblies can be easily removed to the plant shop



Chemstrand's valve repair bench has vise and pressure regulating station on each corner. Clock-like gage on pipe shows air pressure from each regulating station. Note impact wrenches on holder in center of table. Air hose take-up reels are mounted under the table.

for complete maintenance or for factory service if required.

According to Du Pont, if equipment that is not designed along these lines were rejected, pressures would soon be placed on instrument manufacturers so that maintenance costs on these instrument assemblies could be cut substantially. Du Pont says that in the past, instruments were purchased primarily because of the job they would perform. The initial purchase price was the major factor. Installation and maintenance costs seldom played an important part.

New Instruments. Du Pont's experience shows that new instrumentation developments quite often require a considerable amount of maintenance. They give as reasons for high maintenance costs of this equipment the following:

- Special schooling of from 2 to 4 weeks or more for one or more engineers.
- Many component failures, during start-up, often requiring a redesign of the instrument.
- Maintenance manuals arrive at the plant as much as a year after delivery of the equipment. Also, the maintenance manuals often lack information as well as being poorly written.
- Special education is required for instrument mechanics.
- Contract maintenance agreements are made from a distant point which sometimes can be costly and time consuming.
- Maintenance know-how in a plant becomes so special and involved that only a very few, and sometimes only one mechanic, can develop real competence.
- Maintenance was not included by the manufacturer as a design consideration. At best, the maintenance design considerations are often late in the development of the instrument and limited in scope.

Avoiding Maintenance Problems. Many instrument maintenance problems, according to Monsanto, may be avoided by using only those instruments well proven by experience, however, they point out that the price you pay is the lagging behind in the application of new control techniques. Since instrumentation progress increases plant efficiency, this price may be too high.

INSTRUMENT DEPARTMENT ORGANIZATION

Monsanto feels that instrument maintenance departments, although varying widely among companies, commonly are based on skilled mechanics guided by engineers having process know-how.[2] Unfortunately, Monsanto says, instrument maintenance has been loosely

For filled system instruments, the four 10-gallon vessels under the bench provide heated and agitated test liquid.

integrated with the engineering and research departments in the planning and development of advanced instrumentation.

Instrument Shop. Chemstrand Corporation's Pensacola, Fla., plant points out that the instrument shop is the heart of an instrument department.[3]

For automatic valve repair, Chemstrand has built a workbench that provides all of the necessary equipment for fast, efficient valve repair. The 51 x 8 x 118 inch table top has a vise and a pressure regulating station on each corner. A clock-like pressure gage mounted on a pipe in the center of the table gives the instrument mechanic a quick look at the air pressure from each regulating station. Impact wrenches are mounted on a holder welded to the pressure gage pipe at the center of the table and air hose take-up reels are mounted under the bench for quick, easy use. One impact wrench is of the heavy duty type and the other light duty to assist in the dismantling of valves.

A monorail with a chain hoist is located over the bench and eliminates manhandling large valves and clumsy equipment in the shop.

Gage Tests. Chemstrand tests their pressure gages and gage-type transmitters in a separate section of their shop. They have arranged two workbenches with an aisle between them equipped with dead weight testers for these gages. For filled system instruments, four vessels under a bench hold ten gallons of heated and agitated test liquids for calibrating these instruments.

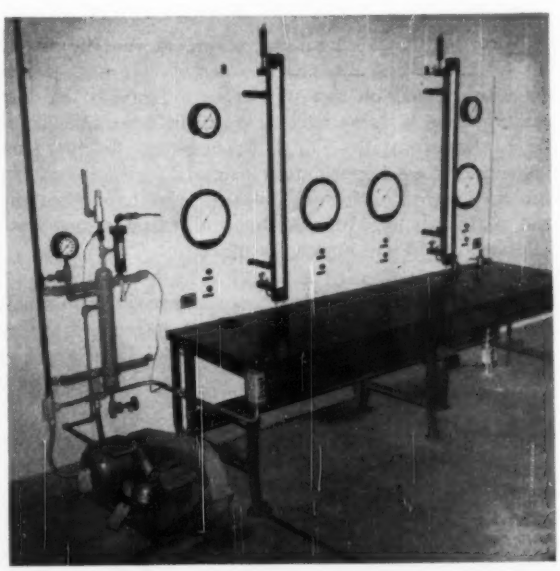
Chemstrand uses a separate pressure test area in their shop in addition to the dead weight testing area, for air calibrating transmitters and other instruments not compatible with oil or water.

An electronic test console was built along one wall of the Instrument Shop and includes test devices such as an oscilliscope, tube tester, vacuum tube voltmeter, etc. The front cover of this console is hinged for easy servicing and the instruments are removable for field use.

Chemstrand uses a separate test area for differential pressure instruments. A number of manometers, gages, barometers and an air supply is mounted for convenient testing of these instruments. Rotating mounting brackets for differential pressure transmitters make checking and calibration an easier, faster job.

Centralized Instrument Shops. Gulf's Port Arthur refinery consolidated five different instrument shops into one centralized shop in 1955.[4] They discovered the improvements were startling and give credit to it doing the following things:

- Items which were duplicated in storing at several points have been eliminated.
- Shop efficiency increased by using the right tools and thus eliminated a backlog of orders on instrument repair.
- Less in-plant travel time is used in locating the right tools and equipment.
- Supervisory efficiency was increased considerably because of the close contact which can be maintained in a centralized shop.
- Instrument mechanic's morale is high because he has the proper tools and shop to work in.



For air calibrating transmitters and other instruments not compatible with oil or water, Chemstrand uses this test bench and 1,000 psig air compressor.

Electronic test console has hinged front cover for servicing or removal of the test instruments for field use. Electrical outlets can be seen along front of the cover.

Spare Parts. An instrument mechanic requires a lot of ingenuity. If he needs a spare part and these is not one available, a well equipped shop and the gadgeteering instinct comes in handy.

Instrument Records. Cities Service Oil Company's Lake Charles plant found that a good card file system definitely reduced instrument maintenance costs.[5] They use an instrument record card which shows the parts frequently requiring replacement and service calls. This gives a quick spot check on certain instruments and instrument designs which are not satisfactory.

Installation Standards. Union Carbide Olefins Company's South Charleston plant feels that installation standards are essential to a well developed instrumentation program. These standards will assure that primary measurement elements are installed properly, that leads are properly sloped, that transmitters and exposed instrument items are properly housed, that case purges are used in zones of corrosive atmospheres, and that the many things needed to be done to make an instrument work properly are included in the installation standards.[6]

Standards will provide assurances that motor valves are installed so that the valve positioner is accessible, that clearance is provided below the valve body, so that the inner valve can be withdrawn without removal of the valve from the line, and that items that are easily overlooked, like spool pieces next to valve flanges, are provided for easy bolt removal. Practices like placing valves and thermowells in inaccessible places will be controlled by standards, and standards will prevent the omission of connections and pressure gages at blind transmitters.

By adopting these and many more installation standards in your own plant or by going over your practices carefully, you will be taking that extra step toward cutting maintenance costs.

Instrument Mechanic Training. Chemstrand Corporation's Pensacola plant decided to train their own instrument mechanics. These men had no previous instrument training and were selected from farm boys, grocery clerks, automobile salesmen, etc. However, they were tested for a good intellectual background and interest in the field of instrumentation.[7]

For a few weeks of the training, the men were placed in the main instrument shop where they learned the fundamentals of the trade including tools, safety and procedures.

The second step was to assign the trainee to an experienced craftsman in an area. Every four months, the trainee was shifted to another area, and another craftsman.

After the trainee worked in the department for 3 to 6 months, he attended a training class twice a week for three hours each time. He studied mathematics and physics, principles of measurement and hydrostatics, hydraulics, pressure and temperature, level measurement, flow measurement, fluid metering and rotameters. He was also given a basic study in the fundamentals of electricity, instruments and electronics.

Chemstrand also encourages advanced work through correspondence courses or local educational institutions and the company has an educational plan to assist their personnel.

Chemstrand feels that this type of program produces better instrument mechanics, more loyal instrument personnel and better instrumentation maintenance in their plants.

National Petro-Chemicals Corporation's Tuscola, Ill., plant says that, "The biggest part of training (instrument mechanics) is getting the men to think in terms of automation. Technicians have to learn the idiosyncracies of instruments so that they can diagnose troubles, distinguish between an instrument problem and one caused by the process itself."[8]

Chemstrand's Decatur, Ala., plant upgraded its Instrument Maintenance Department by also training new mechanics and retraining the old instrument mechanics. The plan called for process engineers and supervisors to conduct classes for the instrument mechanics which gave them a thorough knowledge of the process and its operation.[9] Instrument foremen and engineers conduct training sessions on measurements and control principles and the techniques required for a first class instrument mechanic. The company also calls in instrument vendors to conduct training sessions on particular equipment.

Use is made of instrument manufacturers' factory training schools by sending mechanics to attend the schools then conduct training sessions for other mechanics in the plant.

One practical approach to training was the setting up of a process analog in their instrument shop so that mechanics could practice pneumatic controller tuning.

Maintenance Manual. In addition to these training procedures, Chemstrand standardized on instruments

by making a list of preferred instrument types to keep spare parts low and improve their maintenance proficiency by servicing the minimum number of instrument types. Along with this plan, they adopted a standard procedure manual which consists in the most part of instrument manufacturers' maintenance bulletins.

Contract Instrument Maintenance. Because process instruments are becoming more complex all the time, maintenance requires men skilled and with a thorough knowledge of each instrument as well as the process of which the instrument is a part. For these reasons, many companies have said that they cannot visualize the use of outside contractors to perform maintenance work on their control instruments.

However, Tidewater's Delaware City refinery has contracted instrument maintenance for both preventive maintenance and emergency jobs on practically any type of instrument. In Tidewater's case, the contractor maintains a regular staff of approximately 40 men to handle instrument maintenance.[10] Of course, these men have become as familiar with the particular plant's instruments and the processes as would a resident mechanic. With fringe benefits and responsibilities running so high, other plants are looking into contract maintenance as a means of keeping their instruments in first class working order and at the same time, cutting maintenance costs.

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8. Maintenance Painting

BECAUSE PAINTING represents a large part of the maintenance budget in protecting structures and equipment from corrosion, several steps can be made to cut these costs. Since many coatings last only a few months, the first obvious approach in reducing these costs is to increase the service life of the coating and the second approach is to reduce the cost of the coating job.[1]

Never try to use a coating when the subcoating material will continue to corrode rapidly because of the environment. For example, a coating painted on a steel tank handling hydrochloric acid which is vented, allowing fumes to attack the surface metal, could hardly be expected to protect the metal, and the plant should consider linings or other materials of construction.

The second method of reducing painting costs, according to Du Pont, consists of these following items:

- Use designs to reduce the surface areas to be painted.
- Use tapes as auxiliary protection. For example, taping the edges of structural beams can reduce the painting costs from 28 cents per square foot to 20 cents per square foot.
- Apply coatings by the hot-spray method, which will practically eliminate pinholes in the coating.
- Use coatings with a high solids content. This produces a good film thickness with less coats required to give the same protection.

Standard of Indiana was reported to have cut painting costs by 35 percent in 1956.[2] They substituted rollers for brushes whenever possible and cut their labor cost, which ran 75 percent of the painting budget.

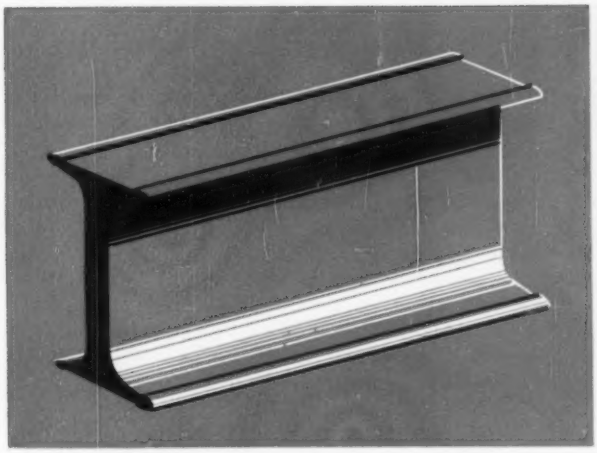
By carefully controlling the surface preparation and the painting mil thickness, Standard of Indiana has been able to increase their paint life so that only 5 percent of their tanks need repainting more often than every 36 months. This compares with a 40 percent repainting schedule for their tanks during 1949 and 1950.

Design for Painting. Monsanto says that plant equipment and structure life can be increased if the protective coating is considered during the design stage.[3]

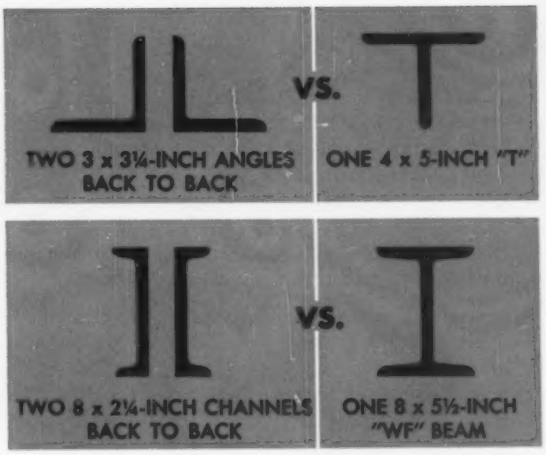
Structures exposed to corrosive atmospheres should be designed so that their surfaces are accessible for proper coating preparation and application. If this is not possible, the Maintenance Department should advise the specification writer to give enough detail so that painting can be done during the erection stage when components are accessible.

The maintenance superintendent should tell structural designers that it is better to use large structural shapes instead of built-up framing requiring many small sections.

The Painting Budget. Phillips Chemical Company's Adams Terminal plant uses a paint and protective coatings engineer to plan its painting budget.[4] He estimates the expenditures that will be made and proposes a



Tape works as auxiliary protection on structural shapes.



Better structural design reduces surface area.

budget for the following year. They have noted that painting costs in their plant average approximately one-half a percent of the total plant investment.

Phillips works its paint and protective coatings engineer very closely with the Maintenance Planning Group. This seems like a fairly obvious step in view of their painting program; however, some plants do not coordinate these groups quite so closely.

Paint Engineers. Monsanto uses a special group to make paint studies in its plants. The head of this group is called a "paint consultant."[5] However, they prefer to call the committee a "Protective Coatings Committee," rather than a paint committee, to indicate the broad scope of the field. This committee makes various basic studies of paints by exposing test specimens to many different environments.

Monsanto feels that a yearly paint schedule is essential for preventive maintenance and that such a schedule will provide the company with the greatest cost savings.

Shell Oil Company has an organization called the "Atmospheric Corrosion Subcommittee."[6] These "paint engineers" develop a painting manual, study special corrosion requirements, do test work and requisition material. They work closely with the paint-craft supervisor as an advisor on all types of coating problems.

Training. Shell found that professional house painters were usually poor industrial painters because they were difficult in receiving instructions on new methods, especially spray painting and were seldom satisfied with employment as spray painters. They found their best painters came from those with high scores on intelligence tests because these men were able to learn industrial painting needs easily, even if they have had no previous painting experience.

Paint Application. In an effort to improve its painting program, Shell supplemented hand-cleaning tools with pads of heavy-grit paper which improved surfaces and reduced cleaning time. They have not been able to use power tools because of the sparking hazard and even though sandblasting is preferred, it presents a sparking problem.

Spray Painting. Shell found that a series of instructions was required for spray painters, especially those who prided themselves in getting the most coverage per gallon. Text books and class instruction films by equipment manufacturers were used. The major points covered were working with low pressures and operating the spray guns close to the surface to be coated with correct gun adjustment for a good pattern. The adding of paint to edges, crevices and irregular areas with the gun held at right angles to the surface being painted was emphasized. Because surface preparation costs are high and repainting is required more often with thin coats, the spray painters were instructed in getting the maximum possible wet-film application without sags or runs.

Tank Painting. Shell found they could cut tank painting time by suspending their stages from pipe or wheel rollers operating on the edge of the roof. The rollers are held at the tank rim by means of cables fastened to the center of the roof. For off-center fixtures, a chain block can be used and played out or pulled in as required during the painting of the tank. Shell's practice is to put two painters on the stage at the top ring of the tank with a man on the roof pulling the coupled rollers along the edge as the work progresses. If they start from the tank stairway and paint continuously to the foam lines, the painters will have continuous travel for one-third to one-half of the tank's circumference. On arrival at the foam line, the stage is lowered one ring for the return painting trip to the stairway. This method cuts down on raising and lowering the stages. It's easier on the painters and adds to total time that the spray painting is being done.

Painting Process Units. For general repainting of process units, Shell uses a pump located near the edge of the area and uses four spray guns with hoses up to 1,200 feet long. After the unit has been cleaned and spot-primed, the hose lines are pulled out the necessary length for painting. They have operated as high as 150 feet above grade. Supply trucks deliver paint stocks to the pump location for continuous supply to the guns. If painting is to continue the next day, the hose lines are left stretched out under pressure and the guns dropped into a pail of distillate to prevent paint from hard-

ening on the gun tips. This method eliminates carrying paint and pressure pots through process units and prevents replenishing the paint supply, all of which materially reduces painting costs.

Using these techniques, Shell has reduced their paint cost per square per year of film life from $9.60 to $1.43 while increasing coverage from two to four coats and getting a final film thickness of 6 mils.

Painting Inspection. Du Pont has set up the following procedures for inspecting a painting job to insure that it meets the specifications.[7] These are the types of checks that a maintenance supervisor should make to be sure that he is getting a good coating job:

- **Surface Preparation.** Du Pont says that a visual inspection should be made of the surface, checking on the degree of cleanliness and freedom from dirt, grease, oil and water, with emphasis on "hard to get at" areas. The profile of blast-cleaned metal surface should be checked by comparison with a reference standard.
- **Periodic Check During Application.** This check merely verifies that the specified materials are used and in the specified manner. A visual check during application should also be made for each coat to see that it is being applied for adequate and acceptable workmanship. Spot checks of each coat for wet film thickness will insure that the specified dry film thickness will be obtained. The inspector should check to see that there has been no contamination between coats. The drying time limitations should be checked and a verification that the surface was primed properly and that the painting was not done during poor weather conditions of extreme temperature and humidity.
- **The Completed Job.** A visual check of the over-all workmanship should be made, a measurement of the total dry film thickness and when specified, a check should be made for coating defects, using a pin-hole detector.

Inspectors. Shell selects their paint inspectors from craftsmen who show a superior intelligence and painting capability.

Records. Du Pont has been able to improve its painting program over the years by keeping records of the cost in cents per square foot per year and a detailed description of the surface preparation, application method and the coating systems.

Phillips keeps a record of the painting jobs for each piece of equipment, which includes any comments about the weather or other conditions which would affect the job. After the painting is completed, it is checked with a magnetic-thickness indicator and with a holiday detector. The mil thickness of each successive paint layer is checked and recorded.

These checks and recorded paint data have reduced Phillips' painting costs considerably.

Scheduling a paint program is quite a job, however, Phillips looks for these advantages in scheduling a paint program.[4]

- A selection of both large and small jobs are available at the same time, which permits full use of the paint crew.
- Work is scheduled in adjoining areas, giving the supervisor a better chance to control the work and inspect it.
- Allowance can be made for unexpected rain by keeping a backlog of inside work available for bad weather days.
- As far as possible, every advantage is taken of the better summer months for painting. This includes adjustment of the paint crew size.
- Further advantage is taken of the good painting season by using outside contractors in addition to the plant painters.

Painting Cost Estimating. Paul Weaver, with Dow Chemical Company's Plaquemine, La., plant, has developed some interesting figures for estimating the cost of an industrial paint job.[8] He says, "To find the gallons of paint required, multiply the percent solids by volume times 16.04, and divide by the total desired dry film thickness in mils. This will give square feet per gallon. Then, divide the total square feet by the square feet per gallon and you get the number of gallons required." If you are able to use the paint completely without thin spots, this is the amount of paint required. However, Weaver says that you should add 5 to 10 percent additional paint if the application is by brush painting techniques and 10 to 20 percent additional paint, and possibly more sometimes, if the application is spray painting. Generally, one gallon of thinner and cleaner is required for each 10 gallons of paint.

In estimating the cost of materials for a painting job, it is advisable to add 10 percent of the total materials cost to allow for miscellaneous items.

Labor. In estimating the cost of labor for painting, Weaver says that for brush painting, "On the average the following square feet should be painted per man-hour, one coat:

Conventional paints—70 to 80 square feet.
Chlorinated rubber—65 to 70 square feet.
Vinyls—60 to 65 square feet.

This should allow ample time for handling materials on the job, mixing, etc., as well as personal fatigue, handling and clean-up time."

Overhead. The problem of a fixed percent for labor overhead is difficult because different companies have varying amounts of employe benefits. However, Weaver suggests that a figure of 40 percent should be added to the labor cost figure which would probably be a representative value.

Miscellaneous. Add 5 percent to the total material and labor cost for miscellaneous equipment, depreciation and supplies.

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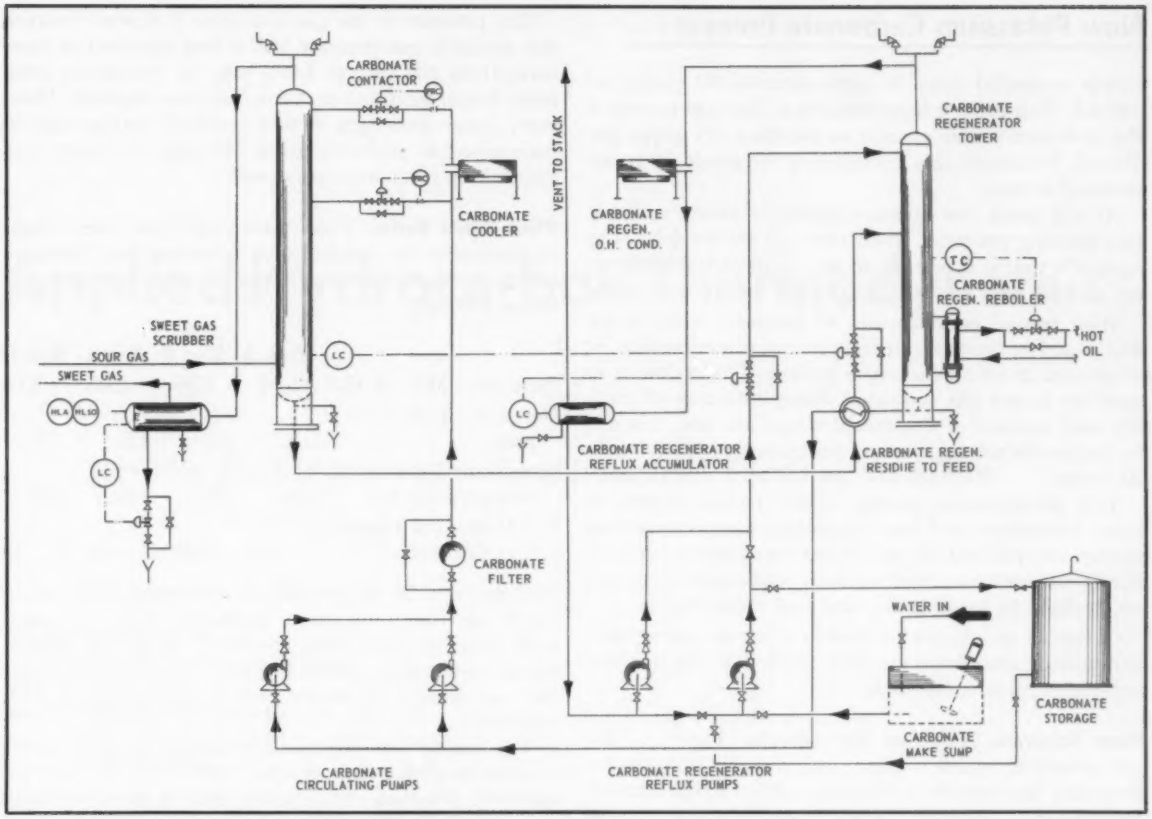

FIGURE 1—Flow scheme for Tellepsen carbonate process.

New Potassium Carbonate Process

With these operating conditions, it's possible to remove CO_2 and H_2S from natural gas to pipe line specifications with an all carbonate process

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Tellepsen Petro-Chem Constructors
Houston

CARBON DIOXIDE and hydrogen sulfide can be removed at the same time from natural gas to pipe line specifications by the use of this new potassium carbonate process. Investment savings are realized by purchasing one process instead of two; operating savings come from lower utility and fuel needs.

During recent years, natural gas producers have sought diligently for more economical processes for treating sour natural gas. With gas uses increasing more rapidly than the discovery of new sweet gas sources, the producers have been forced to take a second look at sour gas fields, especially those that could not have been produced, treated, and processed economically in the past.

The development of the hot carbonate process[1] for the synthesis gas processors was considered by some to have potential merit for natural gas treating. The process has now been adapted to this use and a commercial plant[2] is operating with an amine clean-up unit reducing the acid gas content to pipe line specification. This represents a successful application of the carbonate process and has considerable merit for some processors of sour natural gas.

The hot carbonate process has been used successfully in the synthesis gas plants for the removal of carbon dioxide. Residual quantities of carbon dioxide in the treated gas is not as critical as that required for hydrogen sulfide in pipe line gas. Since absorption of sour gas takes place at, or near, the same temperature as regeneration in this process, the removal of hydrogen sul-

fide is successful down to approximately 20 grains per 100 scf. This process then requires a clean-up to reduce the hydrogen sulfide content to less than .25 grains per 100 scf. Previously, this has required the use of an amine clean-up section.

At this point one question naturally arises; why use two treating processes when one will do the job? The answer is that it is possible to use an all-carbonate process to treat sour natural gas to pipe line specifications.

With special consideration to pressure, temperature and reaction time, the amine clean-up section can be eliminated in an all-carbonate process. This is done successfully in one gas contactor. Since both tray efficiencies and number of theoretical stages are low, this can be accomplished in a tower containing approximately 20 trays.

This all-carbonate process offers the advantages of lower investment and lower operating costs. Investment savings are realized by purchasing one process which is simple to construct and operate. Operational savings are realized by lower utility and fuel requirements.

Chemical savings are realized by using an inexpensive non-volatile absorption medium which does not produce non-regenerable compounds.

Flow Scheme. A typical flow scheme (Figure 1) for this process is to cool the total lean solution from the regenerator by direct heat exchange with the rich solution feed to the regenerator. Temperature reduction may be 50° to 70° F. At this point the lean solution is pumped to the elevated pressure of the contactor. The lean solution stream is split, with one stream entering the middle of the contactor at the pumping temperature. The other stream is cooled 40° to 60° F and introduced into the top of the contactor. The percentage split of these two streams is dependent upon the heat balance of the contactor. If the entering gas is saturated, then it will be necessary for the gas to have a substantial increase in temperature through the contactor. Since appreciable quantities of liquid hydrocarbons will cause foaming, this will prevent condensation in the contactor. A suitable antifoam agent may also be added as a preventive measure.

The top temperature of the gas contactor is critical with respect to residual hydrogen sulfide concentration. This must be maintained below 170° F if pipe line specification gas is desired. The entering gas temperature will influence the split stream cooling and may require gas to gas heat exchange for the most economical heat balance.

The rich solution is withdrawn from the bottom of the contactor at a moderate temperature of approximately 150° F. By exchange, this stream is elevated in temperature to around 200° F. The rich solution is flashed into the regenerator at some predetermined level in the tower. The regenerator is operated near atmospheric pressure, the actual pressure being dependent upon the end use of the acid gases. At this point in the process, a sizable savings is realized. The normal steam requirement for regeneration is from 0.3 to 0.6 pounds of steam per gallon of solution. This represents both investment and operational savings.

The pressure of the gas contactor is dependent upon the available gas pressure but is best operated at pressures from 300 psig to 1,000 psig. At the higher pressures better acid gas pick-up rates are realized. However, lower hydrogen sulfide concentration can be maintained at pressures below 300 psig, but lower acid gas pick-up rates are experienced.

Pilot Plant Data. These pilot plant runs[3] were made to determine the feasibility of achieving low hydrogen sulfide residuals in treated gas at operating pressures below 150 psig:

	Run A	Run B	Run C	Run D
Feed gas—Mol. % H_2S	2.06	2.06	2.06	2.06
Contactor Pressure—psig	115.	115.	135.	110.
Contactor Top Temperature ° F	135.	135.	145.	165.
H_2S Content of Treated Gas GR/100scf	.17	.22	.08	.12

Pick-up rates of 40 percent of theoretical were established at these operating pressures. This compares with pick-up rates that are from 10 to 50 percent higher at pressures above 300 psig. This work was carried out using a 25 weight percent regenerated K_2CO_3 solution.

This article was intentionally limited in scope to the introduction of a new process tool to the natural gas industry. A second article will appear in the near future presenting plant operating data.

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Applied Hydrocarbon Thermodynamics

Part 15b: Flash Vaporization Conditions from Terminal Volatilities

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How to Predict EFV Conditions. The preceding equations, charts, and illustrations are for predicting the TBP curves of the equilibrium vapor and liquid from flash vaporization of petroleum fractions. Relative volatility vs. temperature relationships were used to define the mixtures as well as express its vaporization behavior. The K values of the references (in this case the 350° F boiling point) were not required in this calculation. Conditions (i.e., T and P at any given percent distilled) are not required. Relationships for finding these conditions will be developed now.

The constant, I, for the development of these equations was determined by computing $\int y\,d\alpha$ from Equation (15.3b) and setting the integral equal to unity, which operation follows from the general rule that the integral of any composition distribution function over its whole range of volatility is equal to unity. With the constant I thus determined, the volatility curves are next formulated from these composition distribution functions.

It was shown above that the volatility characteristics of most petroleum fractions could be represented by a straight line on semilog paper (i.e., log α vs. W_F). Differentiation of this relationship, combining with the general equations for volatility curves and integration, gives the useful equations for the TBP curves of equilibrium vapor and liquid.

In this previous work the constant I dropped out of the equations, as did the temperature-pressure conditions for the equilibrium flash vaporization. The answer to the temperature-pressure conditions involves the integration constant, I.

Differentiating the straight line log volatility relationship of Equation (15.6) gives

$$dW_F = \frac{d\alpha}{\alpha} \frac{1}{\log \frac{\alpha_i}{\alpha_e}} \qquad (15.9)$$

combining with the definition

$$x = \frac{dW}{d\alpha}$$

gives

$$x_F = \frac{1}{\alpha} \frac{1}{\log \frac{\alpha_i}{\alpha_e}} \qquad (15.10)$$

combining Equations (15.3b) and (15.10)

$$y = \frac{1}{[V\alpha + (1-V)\,I]\left[\log \frac{\alpha_i}{\alpha_e}\right]} \qquad (15.11)$$

Integrating $y\,d\alpha$ over entire range and setting equal to unity

$$\int y\,d\alpha = 1 = \frac{1}{\log \frac{\alpha_i}{\alpha_e}} \int_{\alpha_e}^{\alpha_i} \frac{d\alpha}{V\alpha + (1-V)\,I}$$

from which

$$I = \frac{V}{1-V} \alpha_e \frac{\left(\frac{\alpha_i}{\alpha_e}\right) - \left(\frac{\alpha_i}{\alpha_e}\right)}{\left(\frac{\alpha_i}{\alpha_e}\right)^V - 1} \qquad (15.12)$$

Equation (15.12) gives the values of I as a function of the amount flashed and the terminal α values.

From Equation (15.2) a relationship between this integration constant and the equilibrium vapor-liquid distribution ratio of the reference component is obtained, as follows:

The relative volatility relationship used in the above derivations and applications was based on liquid volume

quantities, while the vapor-liquid equilibrium K values are mole fraction ratios (i.e., $K = y/x$). In relating the results from the solution of these integral equations with the mole fraction ratio K values, it is necessary to use the following conversion factor

$$\frac{M_L}{M_V}$$

where: M_L = moles/100 gallons of equilibrium liquid product

M_V = moles/100 gallons of equilibrium vapor product

This factor is required where liquid volume units of measure are used in the TBP assay and the calculations.

By combining the definition of K (i.e., $K = y/x$) with Equation (15.2a) and the above factor

$$K = \frac{y}{x} = \frac{\alpha}{I}\frac{M_L}{M_V} \qquad (15.13)$$

but $K = \alpha K_r$, where K_r is K value for reference component, giving

$$K_r = \frac{1}{I}\left(\frac{M_L}{M_V}\right) \qquad (15.14)$$

Combining Equations (15.12) and (15.14)

$$\alpha_e K_r = \frac{\alpha_e}{I}\left(\frac{M_L}{M_V}\right) = \frac{1-V}{V}\left[\frac{\left(\frac{\alpha_1}{\alpha_e}\right)^V - 1}{\left(\frac{\alpha_1}{\alpha_e}\right) - \left(\frac{\alpha_1}{\alpha_e}\right)^V}\right]\left(\frac{M_L}{M_V}\right) \qquad (15.15)$$

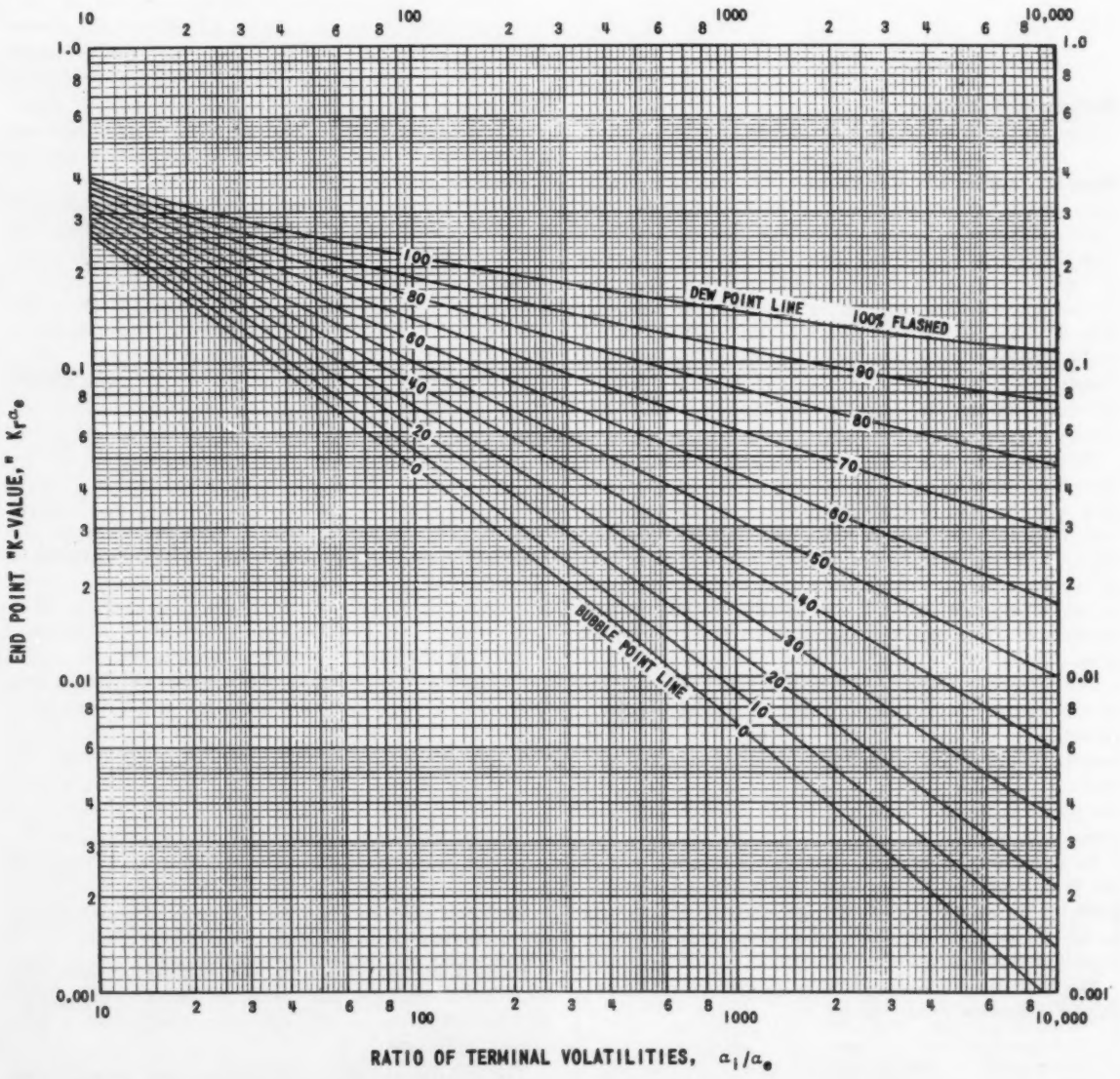

FIGURE 15.9—The integration constants are related to terminal relative volatilities and percent flash distilled.

Equation (15.15) applies to values of V intermediate between 0 and 1.0 but is indeterminate at V = 0 and V = 1.0.

At the bubble point, where V = O, the constant I is found by evaluating the integral $\int y_F d\alpha$, where y_F is the vapor composition in equilibrium with x_F, as defined by Equation (15.2a), and setting this integral equal to unity.

The equilibrium equation

$$y_F = \frac{\alpha x_F}{I}$$

is combined with Equation (15.10) to give

$$y_F = \frac{1}{I \log \frac{\alpha_i}{\alpha_e}} \qquad (15.16)$$

The bubble point integral is evaluated

$$\int_{\alpha_e}^{\alpha_i} y_F \, d\alpha = \int_{\alpha_e}^{\alpha_i} \frac{d\alpha}{I \log \frac{\alpha_i}{\alpha_e}} = 1 \qquad (15.17)$$

giving

$$I = \frac{\alpha_i - \alpha_e}{\log \frac{\alpha_i}{\alpha_e}} \qquad (15.18)$$

Combining Equations (15.14) and (15.18)

$$\alpha_e K_r = \frac{\alpha_e}{I}\left(\frac{M_L}{M_V}\right) = \frac{\log \frac{\alpha_i}{\alpha_e}}{\alpha_i - \alpha_e}\left(\frac{M_L}{M_V}\right) \qquad (15.19)$$

Equation (15.19) applies at the bubble point only.

At the dew point, where V = 1.0, the constant I is found by evaluating the integral $\int x_F d\alpha$ in a similar manner.

Starting with the equilibrium equation

$$y_F = \frac{\alpha x_F}{I}$$

Divide by α and integrate through the whole range of composition

$$\int_{\alpha_e}^{\alpha_i} \frac{y_F}{\alpha} d\alpha = \frac{\int_{\alpha_e}^{\alpha_i} x_F d\alpha}{I} \qquad (15.20)$$

Applying the condition $\int x_F d\alpha = 1$, at the dew point, gives

$$\frac{1}{I} = \int_{\alpha_e}^{\alpha_i} \frac{y_F}{\alpha} d\alpha \qquad (15.21)$$

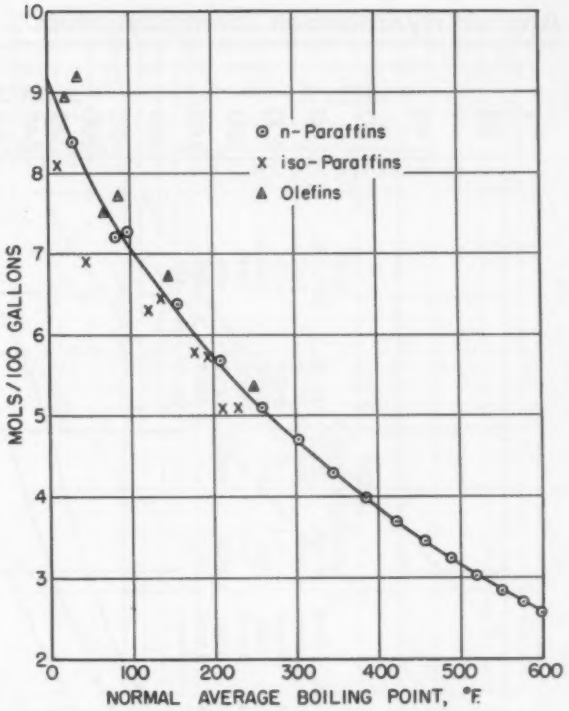

FIGURE 15.10—Moles/100 gallons vs. boiling point relationship for correcting liquid volume units to mole fraction ratios.

A relation similar to Equation (15.10) may be written for y_F

$$y_F = \frac{1}{\alpha} \frac{1}{\log \frac{\alpha_i}{\alpha_e}} \qquad (15.22)$$

Combining Equations (15.21) and (15.22) gives

$$\frac{1}{I} = \int_{\alpha_e}^{\alpha_i} \frac{d\alpha}{\alpha^2 \log \frac{\alpha_i}{\alpha_e}} \qquad (15.23)$$

Integrating

$$\frac{1}{I} = \frac{\alpha_e^{-1} - \alpha_i^{-1}}{\log \frac{\alpha_i}{\alpha_e}} \qquad (15.24)$$

Combining Equations (15.14) and (15.24)

$$\alpha_e K_r = \frac{\alpha_e}{I}\left(\frac{M_L}{M_V}\right) = \frac{1 - \frac{\alpha_e}{\alpha_i}}{\log \frac{\alpha_i}{\alpha_e}}\left(\frac{M_L}{M_V}\right) \qquad (15.25)$$

Equation (15.25) applies at the dew point only.

Figure 15.9 is a graphical solution for α_e/I in Equations (15.15), (15.19) and (15.25).

Ratio of Moles Per 100 Gallons For Equilibrium Products. True boiling point curves, which are on temperature vs. liquid volume percent distilled, must be

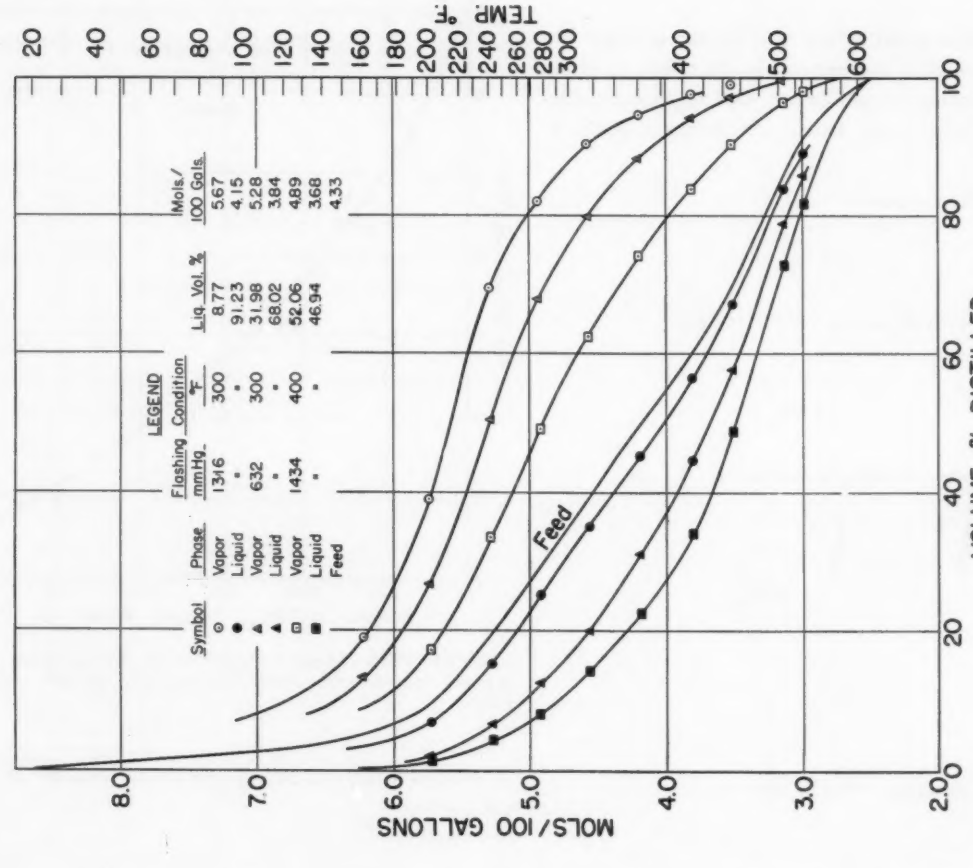
TEMP °F
MOLS/100 GALLONS
VOLUME % DISTILLED
LEGEND
Symbol | Phase | Flashing mmHg | Condition °F | Liq. Vol. % | Mols./100 Gals.
○ Vapor 1316 300 8.77 5.67
● Liquid " " 91.23 4.15
△ Vapor 632 300 31.98 5.28
▲ Liquid " " 68.02 3.84
□ Vapor 1434 400 52.06 4.89
■ Liquid " " 46.94 3.68
Feed 4.33

FIGURE 15.12—Calculated TBP curves for equilibrium vapors and liquids on moles/100 gallons vs. liquid for data from flash vaporization of crude gasoline fraction.

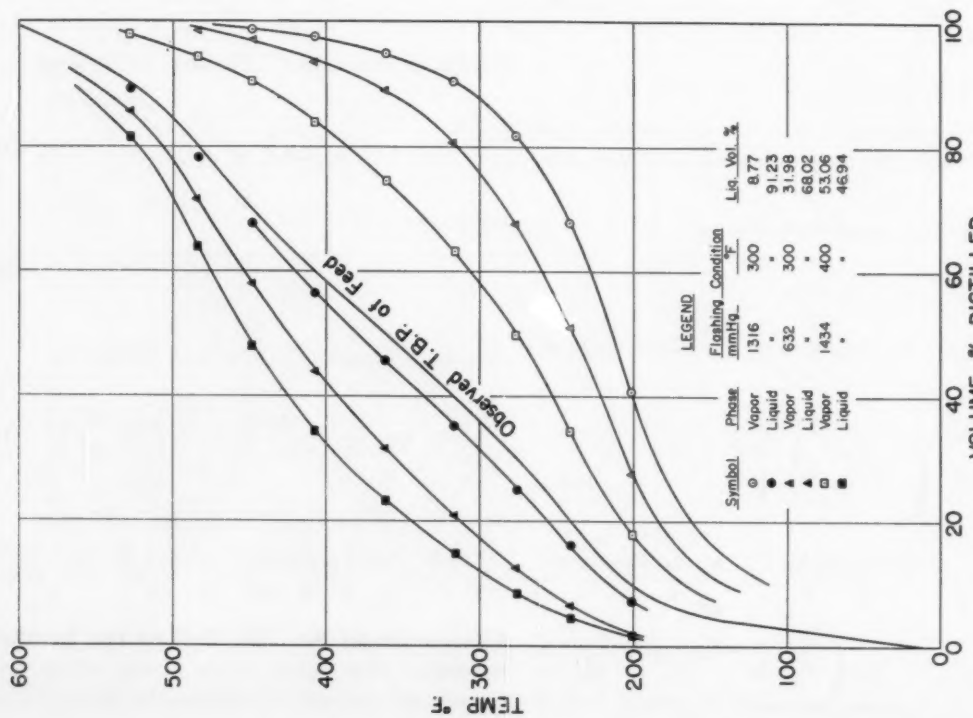
TEMP °F
VOLUME % DISTILLED
Observed T.B.P. of Feed
LEGEND
Symbol | Phase | Flashing mmHg | Condition °F | Liq. Vol. %
○ Vapor 1316 300 8.77
● Liquid " " 91.23
△ Vapor 632 300 31.98
▲ Liquid " " 68.02
□ Vapor 1434 400 53.06
■ Liquid " " 46.94

FIGURE 15.11—Calculated TBP curves for equilibrium vapors and liquids from flash vaporizations of crude gasoline fraction.

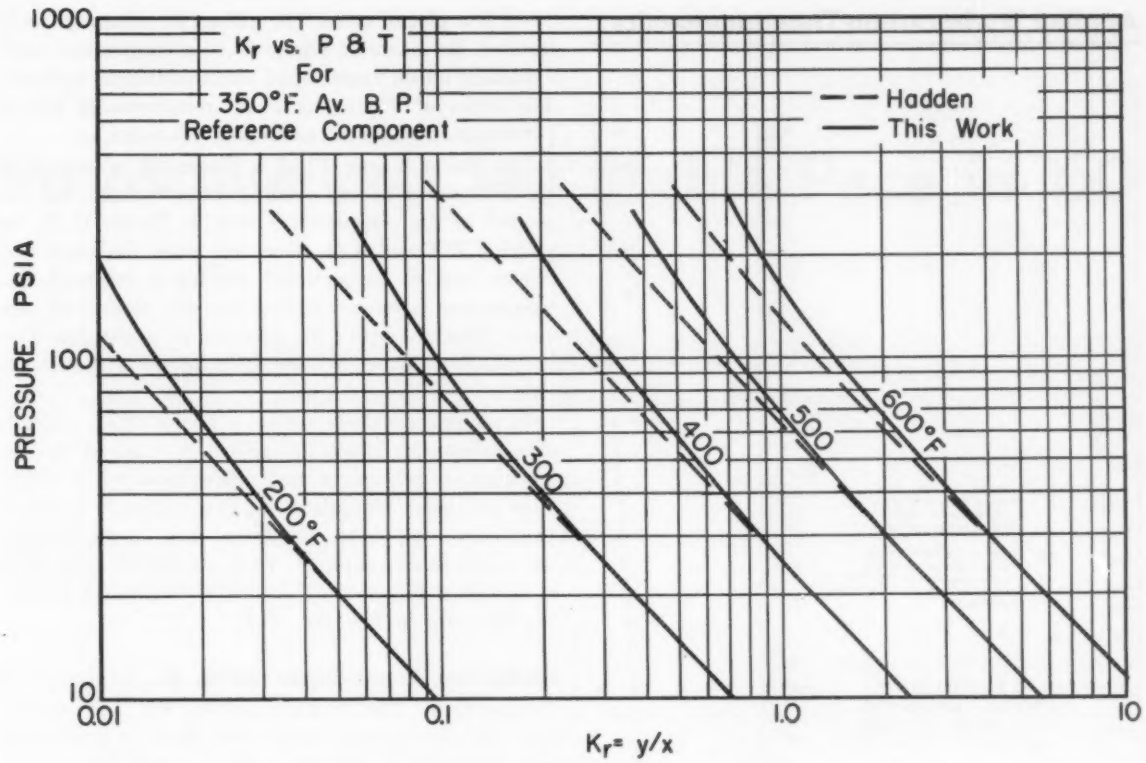

FIGURE 15.13—K_r vs. pressure and temperature for 350° F average boiling point reference component.

converted to a molar basis for calculations of equilibrium conditions by use of the K values. In Part 14 two such correlations were presented for use with the graphical form of the integral method. The analytical solution given here for the conditions of equilibrium vaporization could use the same molar volume correlation.

An alternate liquid volume to moles conversion method is given here because this is the correlation that was used in solving the example already available to illustrate this method.

A graphical method of evaluating the ratio of moles per 100 gallons for the equilibrium liquid and vapor products from any flash vaporization has been developed and is shown in Figures 15.10, 15.11, and 15.12.

In Figure 15.10 the moles/100 gallons is plotted against normal average boiling point for paraffinic and olefinic hydrocarbons. A single curve is taken to represent this relationship because only relative values of the ordinate are of interest, and similar deviations from the absolute values will appear in numerator and denominator. Aromatic and other hydrocarbons are omitted because the proposed method is limited to systems having more nearly ideal volatility characteristics.

In using the relationship given by the curve in Figure 15.10, the assumption is made that each temperature on the TBP distillation curve corresponds to a given moles/100-gallon value. It is not claimed that this is true in an absolute sense but that it is sufficient for these purposes.

Using the relationship given in Figure 15.10, a method of plotting the TBP curves of the equilibrium vapor and liquid products is devised that yields by graphical integration (by planimetering or square count-

TABLE 15.5—Calculation of Reference Component K Values for Experimental Equilibrium Flash Vaporization Data on Two Petroleum Fractions

Stock	Observed Flashing Conditions			Terminal Values of Relative Volatility		$\frac{\alpha_e}{I} = \left(\frac{1-V}{V}\right)\left[\frac{\left(\frac{\alpha_i}{\alpha_e}\right)^V - 1}{\left(\frac{\alpha_i}{\alpha_e}\right) - \left(\frac{\alpha_i}{\alpha_e}\right)^V}\right]$	$\frac{M_L}{M_V}$ (Fig. 15.12)	Values of K_r	
	Pressure Gage	Temp. °F	Fraction Vaporized	α_i	α_e			$K_r = \frac{1}{\alpha_e}\left(\frac{\alpha_e}{I}\right)\left(\frac{M_L}{M_V}\right)$	K_r (Fig. 15.13)
Naph-	0 lb./sq. in.	300	0.308	26.7	0.0149	0.01142	0.659	0.505	0.50
Kero	50 lb./sq. in.	400	0.199	13.5	0.035	0.02385	0.692	0.471	0.46
Blend	100 lb./sq. in.	600	0.706	5.2	0.12	0.1907	0.797	1.27	1.27
Crude	1316 mm Hg	300	0.0877	20.0	0.0315	0.01258	0.732	0.292	0.29
Gasoline	632 mm Hg	300	0.3198	20.0	0.0315	0.024	0.728	0.555	0.56
Fraction	1434 mm Hg	400	0.5206	10.5	0.065	0.0815	0.753	0.94	0.94

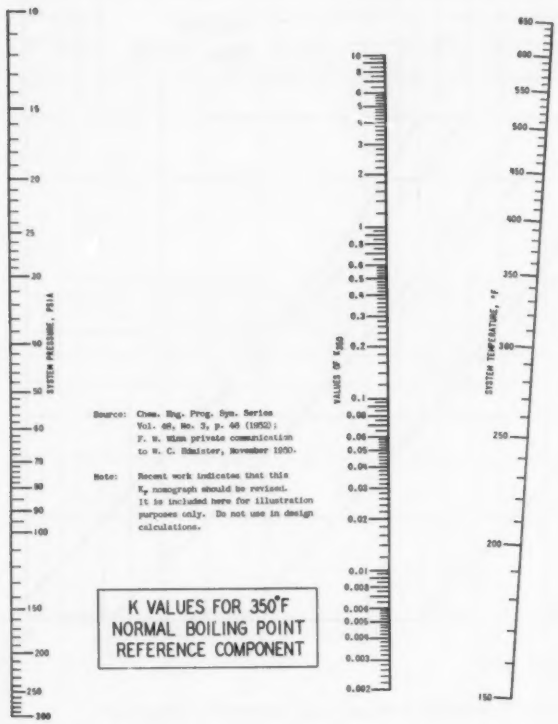
SYSTEM PRESSURE, PSIA
VALUES OF K350
SYSTEM TEMPERATURE, °F
Source: Chem. Eng. Prog. Sym. Series Vol. 48, No. 3, p. 46 (1952); F. W. Winn private communication to W. C. Edmister, November 1950.
Note: Recent work indicates that this Kr nomograph should be revised. It is included here for illustration purposes only. Do not use in design calculations.
K VALUES FOR 350°F NORMAL BOILING POINT REFERENCE COMPONENT

FIGURE 15.14—K_{350} nomograph for sample calculations.

ing) the approximate moles/100 gallons for these products. A ratio of these values for liquid and vapor gives the correction factor desired.

This method of plotting is illustrated in Figures 15.11 and 15.12, Figure 15.11 being a conventional plot of the TBP curves obtained earlier in this installment for the equilibrium vapor and liquid products from three flash vaporizations of a crude gasoline fraction. Figure 15-12 is a plot of moles/100 gallons vs. volume percent distilled. By means of Figure 15.10 a temperature scale is marked off on Figure 15.12 as an additional ordinate. The scales of Figure 15.12 are recommended for all petroleum fractions not containing aromatics, etc.

The use of Figure 15.12 is illustrated by replotting the TBP curves for the crude gasoline fraction that are plotted in the conventional form in Figure 15.11. In plotting TBP curves on these new scales the same procedure used in conventional plotting is followed, i.e., temperature is plotted against percent distilled or vice versa. This eliminates the necessity of a plot like Figure 15.11, which is included for purposes of illustration only.

In plotting the TBP curves on Figure 15.12, a graph of instantaneous moles/100 gallons is obtained. An integration of each one of these curves from 0% to 100% gives the moles/100 gallons for that particular fraction. Each curve was planimetered, and these moles/100-gallon values were computed. These results are entered in the legend of Figure 15.12. Ratios of these values give the M_L/M_V term in Equation 15.4.

TABLE 15.6—Equilibrium Vapor-Liquid Distribution Ratio for 350° F AV BP Reference Component

Lb./Sq. In. Abs.	200° F	300° F	400° F	500° F	600° F
10	0.096	0.70	2.32	5.70	11.9
15	0.066	0.48	1.61	3.90	7.9
20	0.050	0.37	1.23	2.95	6.0
30	0.036	0.255	0.830	2.00	4.0
40	0.029	0.200	0.675	1.57	3.10
60	0.0212	0.144	0.485	1.09	2.19
80	0.0175	0.116	0.385	0.85	1.71
100	0.0150	0.100	0.325	0.71	1.42
150	0.0117	0.076	0.24	0.51	1.05
200	0.0100	0.064	0.20	0.42	0.88

TABLE 15.7—Comparison of K Values for 350° F ATM BP Component from Hadden Nomograms, from White and Brown, and from Figure 15.13

	K = y/x, 100 Lb./Sq. In. Abs.		K = y/x, 200 Lb./Sq. In. Abs.		
Flashing Temp., °F	Hadden (39)	Figure 15.5	White and Brown (40)	Hadden (39)	Figure 15.5
500	0.65	0.71	0.42	0.36	0.42
600	1.25	1.42	0.90	0.70	0.88

Equilibrium Vapor-Liquid Ratio, K_r. In Part 15a discussions of TBP transformations, the TBP curves were calculated for the equilibrium products from three flash vaporizations of two stocks, a naphtha-kerosene blend, and a crude gasoline fraction. These calculations did not include a check of the temperature-pressure conditions of vaporization. This latter calculation can be made with results from the graphical constructions of Figure 15.12 plus a plot of the equilibrium vapor-liquid ratio, K_r, for the reference component.

Such calculations are given in Table 15.5 with the calculated K_r values for these experiments and the K values of Hadden[39] and of White and Brown,[40] Figure 15.13 was constructed for the reference component, i.e., the 350° F average boiling point narrow fraction. Values of K_r were read from Figure 15.13 for the temperature and pressure conditions of these experiments and are entered in Table 15.6 for comparison with the calculated values of K_r.

The K data obtained from the flashing experiments on petroleum stock via the computations in Table 15.5 are in good agreement with the experimental observations of White and Brown,[40] which data were obtained in another manner. Only at pressures near atmospheric do the values from Hadden[39] agree with the K data from these other sources. This is illustrated in Figure 15.13.

Table 15.7 gives a comparison of K values for the reference component from different sources at two temperatures and pressures. It will be noted that Figure 15.13 is in good agreement with White and Brown[40] at 200 psia.

(References and nomenclature at end of Part 15a, December 1959 PETROLEUM REFINER.)

TO BE CONTINUED

Petrochemicals Set Stable Pace in '60

Two-year hindsight shows minor growth for 1960. However, plan now for new plants needed in the early 1960s

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LONGER RANGE TRENDS in petrochemical production become more apparent by looking back two years.[4] During this period, a moderate business recession followed by a rapid recovery resulted in rapid changes in petrochemical sales and production.

With the general slow-down in 1958 and 1959 of planning and contracting for new petrochemical facilities, currently increasing production indicates the possibility of a tight supply situation developing for some products in 1961-63. Petrochemical producers, present and potential, should be planning now for the coming expansion.

PRICE TRENDS

Stable. Although minor short-term variations in prices have been noted during the two year period (particularly in such items as ammonia), the over-all picture has been one of stability. Several of the stable items listed in Table 1 have held at essentially fixed price levels for the past three to five years.

Up. Only three major petrochemicals show an upward price trend. These rises can be traced directly to limited capacity for petrochemical production, and, as in the case of ethanol, higher cost production from other sources.

Down. Many key items have decreased in price. Most decreases parallel increased petrochemical production capacity. In some cases (acrylonitrile, methanol, styrene) the change in price also reflects the growth and availability of other competitive petrochemical products. In the group of aromatics, the substantial price reductions reflect improved quality and lower price of the previously low-grade coal tar products.

Trend. The trend toward stable pricing is healthy, but the major decreases in prices noted, occurring during a period of rising costs, indicate a profit squeeze on older producers, as new, more efficient installations come on stream. Opportunities for satisfactorily profitable petrochemical operations are becoming more limited—and the prospective producer must become much more selective with respect both to product and process selection.

CAPACITY ESTIMATES

Industry-wide capacity estimates are always difficult to make, including as they must in-plant capacity increases obtained by elimination of bottlenecks and by installations of auxiliary equipment. Public announcement of new-plant installations, or plant expansions, have generally been the most reliable source of information upon which to adjust capacity figures. The past two years have been notable, however, for the unusual number of announcements for new plant installations, which have been followed by later news of project cancellations and postponements, and in some cases no action, but utter silence.

Capacity Up. Despite the brief business recession of 1958, there has been an appreciable increase in petrochemical capacity during the past two years. This stems from the fact that plants completed and started up during this period were already committed and under construction when the recession hit. Effects of the recession, as indicated by the very small volume of new plant contracts in 1959, will show up in 1961, which should show very little increase in capacity over 1960.

Referring to the first two columns of Table 2, total estimated capacities for the major petrochemicals are given. These figures cover both petrochemical and non-petrochemical sources. 1958 estimates come from an earlier paper by this author.[4]

Olefins. It is immediately apparent that ethylene is still the most promising hydrocarbon intermediate for petrochemical production, with 25 percent capacity increase in the two year period. Propylene is the comer, with a 20 percent capacity increase estimated. Butylenes and butadienes, indicating substantial over-capacity, have shown little or no gain over the two year period. Acetylene capacity increase, surprisingly, is mostly in non-petrochemical carbide installa-

tions—the latter is still more economic in many heavily industrialized areas having low electric power costs.

Aromatics. All aromatic intermediates show substantial capacity increases over the two year period. These are all new petrochemical installations. Non-petrochemical (particularly coke-oven) producers have achieved competitive quality standards by installing petrochemical type finishing or refining facilities for their hitherto crude products.

Polymers. Polyethylene's major capacity increase is mainly in the low-pressure product. Polypropylene is the new comer—just entering the field in 1958. The five-fold increase in capacity for the two year period is indicative of the high hopes held for this product. Synthetic rubber capacity is ample, with no expansion recorded.

Phenol capacity has increased, through new synthetic facilities. Ammonia, though showing considerable over-capacity in 1958, has grown more during the past two years. This growth is due to the opening of new plants in consuming areas where freight rates favor the local producers. Urea capacity expansion has been substantial—almost 30 percent over the two-year period. The need to store and use some of the available ammonia in more useful form has favored this expansion.

Aliphatic chemical production capacity, now almost entirely petrochemically based, shows only moderate expansion in the period 1958-1960. The acetyl chemical group accounts for a moderate increase of 10-20 percent while, ethylene oxide and ethylene glycol indicate a 15 percent capacity increase. Acrylonitrile capacity increased as much as 20 percent.

PRODUCTION

To facilitate evaluation of production trends, several comparisons are made in columns 3 through 8 of Table 2. Reported production figures for 1957 and 1958 are listed in columns 3 and 4. For comparison, the author's estimates for 1958,[4] actually made in 1957, are given in column 5. Comparison of estimated and actual 1958 figures reflects both the inaccuracies of prediction, and effects of the brief business recession. Estimates are given in column 8 of the proportion of production which was from petrochemical sources in 1958.

Aliphatic hydrocarbon intermediates production showed a mixed reaction to 1958 business trends. Ethylene and butadiene output fell appreciably below what was estimated from prior trends. On the other hand, propylene production increased appreciably, as did butylene. Acetylene manufacture showed only a moderate gain.

In the aromatic intermediate group, benzene registered an unexpected major decrease in output, styrene held steady, and toluene and xylene yielded appreciable increases.

Polyethylene registered the anticipated major increase in production during 1958 estimated for this growth petrochemical. Synthetic rubber dropped slightly, but exceeded the earlier estimate for 1958.

Phenol production for 1958 dropped appreciably below 1957 output, to a level far below estimates. Ammonia, on the other hand, indicated a slight increase in volume. Urea production increased appreciably, in line with estimates.

In the **aliphatic** chemical group, production of most compounds in 1958 ran well behind estimates. Formaldehyde, acetaldehyde, methanol, iso-propanol, ethylene oxide, ethylene glycol, glycerol, and acrylonitrile output reached levels only equal to or slightly less than 1957 records. Ethanol, however, showed a major gain in production, as compared with estimates. Appreciable production gains for 1958 over 1957 also were recorded for butanols, glycerol, acetic acid, acetic anhydride, vinyl chloride and vinyl acetate. All of the chlorinated aliphatic hydrocarbons showed substantial decreases in output for 1958 as compared with 1957.

Table 1—Price Trends for Major Petrochemicals[1]

(Cents per pound, except where noted)

	3rd Quarter 1957	3rd Quarter 1959
Stable		
▶Acetaldehyde	10	10*
▶Acetic Acid	10	10
▶Acetic Anhydride	14	14+
▶Acetone	8½	8½
▶Ammonia	4¼	4¼
▶Butanol (secondary)	12½	12½
▶Ethylene Glycol	13½	13½*
▶Ethylene Oxide	15½	15½+
▶Vinyl Acetate	17½	17½
▶Vinyl Chloride	11	11
Increases		
▲Carbon Tetrachloride	10¾	11¾
▲Ethanol (per gallon)	47	52
▲Iso-Propanol (per gallon)	41	42
Decreases		
▼Acrylonitrile	28	27
▼Benzene (per gallon)	36	31
▼Butadiene	15½	14½
▼Methanol (per gallon)	32½	30
▼Phenol	18¼	16½
▼Styrene	12½	12
▼Toluene (per gallon)	31	25
▼Xylene (per gallon)	34	29

* Stable 3 years
+ Stable 5 years

PROJECTION FOR 1960

As this article is written prior to the end of the 1959 production year,

Table 2—Major Petrochemicals—Capacity and Production*

(Millions of Pounds)

	CAPACITY ESTIMATES		PRODUCTION					Percent Petro-chemical
			Actual		Estimated			
	1958[4]	1960	1957	1958	1958[4]	1959	1960	1958
Hydrocarbon Intermediates								
Aliphatic								
Ethylene	4500	5600	3947[2]	4149[2]	4500	4500	5000	100
Propylene & Mixtures	1900	2300	1786[2]	2016[2]	1750	2100	2300	100
Butylene & Mixtures	2600	2600	1678[2]	2027[2]	2000	2100	2150	100
Butadiene	2200	2200	1542[2]	1443[2]	1600	1600	1700	100
Acetylene	1100	1250	600	650	650	700	750	25
Aromatic								
Benzene	3500	3700	2300[2]	2000[2]	2800	2200	2300	52
Toluene	2400	2700	1420[2]	1720[2]	1500	1800	1850	82
Xylene	1500	2000	950[2]	1500[2]	1150	1600	1650	92
Styrene	1300	1500	1166[2]	1224[2]	1250	1250	1300	60
Hydrocarbon Polymers								
Polyethylene	1200	1500	708[3]	865[2]	850	950	1100	100
Polypropylene	20	100	.....	.....	....	20	50	100
Synthetic Rubber	2800	2800	2354[3]	2202[2]	2050	2300	2400	70
Phenol	700	850	556[3]	506[3]	625	550	575	72
Ammonia	10000	11000	7000	7500	7000	8000	8500	95
Urea	1300	1700	960[3]	1061[2]	1100	1200	1300	90
Aliphatic Chemicals								
Formaldehyde (100%)	920	950	499[2]	502[2]	570	550	575	95
Acetaldehyde	1000	1200	900	900	925	925	950	90
Methanol	2000	2200	1534[2]	1435[2]	1750	1500	1600	99
Ethanol	2800	2800	1550[2]	1630[2]	1400	1650	1650	85
Iso-Propanol	1200	1250	1191[3]	1029[2]	1150	1075	1100	100
Butanols	600	650	487[3]	505[2]	550	525	550	60
Ethylene Oxide	1300	1600	1236[3]	1051[2]	1250	1300	1400	95
Ethylene Glycol	1300	1500	1200[2]	1145[2]	1150	1175	1250	90
Glycerol	400	430	230	210	300	230	250	50
Acrylonitrile	300	360	174[3]	178[2]	220	230	270	100
Acetic Acid	780	950	524[2]	566[2]	600	600	620	97
Acetic Anhydride	1000	1100	912[2]	965[2]	925	1000	1050	97
Acetone	800	850	651[2]	611[2]	650	630	650	83
Carbon Tetrachloride	350	375	318[2]	313[2]	330	325	340	....
Ethyl Chloride	....	.....	604[3]	536[2]	700	550	570	....
Ethylene Dichloride	.....	.....	800[2]	773[2]	620	775	790	....
Trichloroethylene	....	.....	338[2]	295[2]	400	320	340	....
Perchloroethylene	.....	.....	197[2]	187[2]	220	220	220	....
Vinyl Chloride	800	850	627[2]	691[2]	680	720	750	....
Vinyl Acetate	.....	.....	172[2]	190[2]	210	210	230	...

* Total capacity and production-petrochemical and other sources.

estimates for this year as well as 1960 are presented (columns 6 and 7 of Table 2). The general pickup in petrochemical production was notable in the first half of 1959, and despite the effects of the steel strike on the latter half of the year's operation, over-all levels for 1959 should be appreciably better than 1958. Further growth at a moderate rate is predicted for petrochemical output in 1960.

All of the **aliphatic** hydrocarbon intermediates should increase, with largest proportionate gains registered by ethylene and propylene; and capacity limitations indicated for the latter material. Acetylene output, though estimated to increase, still is not showing the major gains in petrochemical areas predicted several years ago. Aromatic hydrocarbon intermediates should show only a modest production gain. Excess capacity for these products ranges from moderate to substantial.

Polyethylene should continue its phenomenal growth in 1960. It will be joined with the even more rapidly growing newcomer, polypropylene. Despite the apparent excess in production capacity for 1960, that year will probably see announcement of plans for additional installations. Synthetic rubber should continue its moderate growth rate, aided by improved auto sales.

Phenol output should resume its growth, but at a moderate rate. Ammonia and urea are also estimated to show greater production in 1960, the latter proportionately more than the former. All products in this category are indicated to have substantial surplus production capacity.

None of the aliphatic chemical group is expected to show an unusual increase in production for 1960 over 1959. Normal growth gains of the order of 3 to 5 percent may be exceeded only by methanol, ethylene oxide and ethylene glycol. Substantially all of the products in this group are indicated to have moderate to substantial surpluses of production capacity over requirements for 1960. A few, such as isopropanol, synthetic ethanol, acetic anhydride and carbon tetrachloride, may soon approach the point of tight supply.

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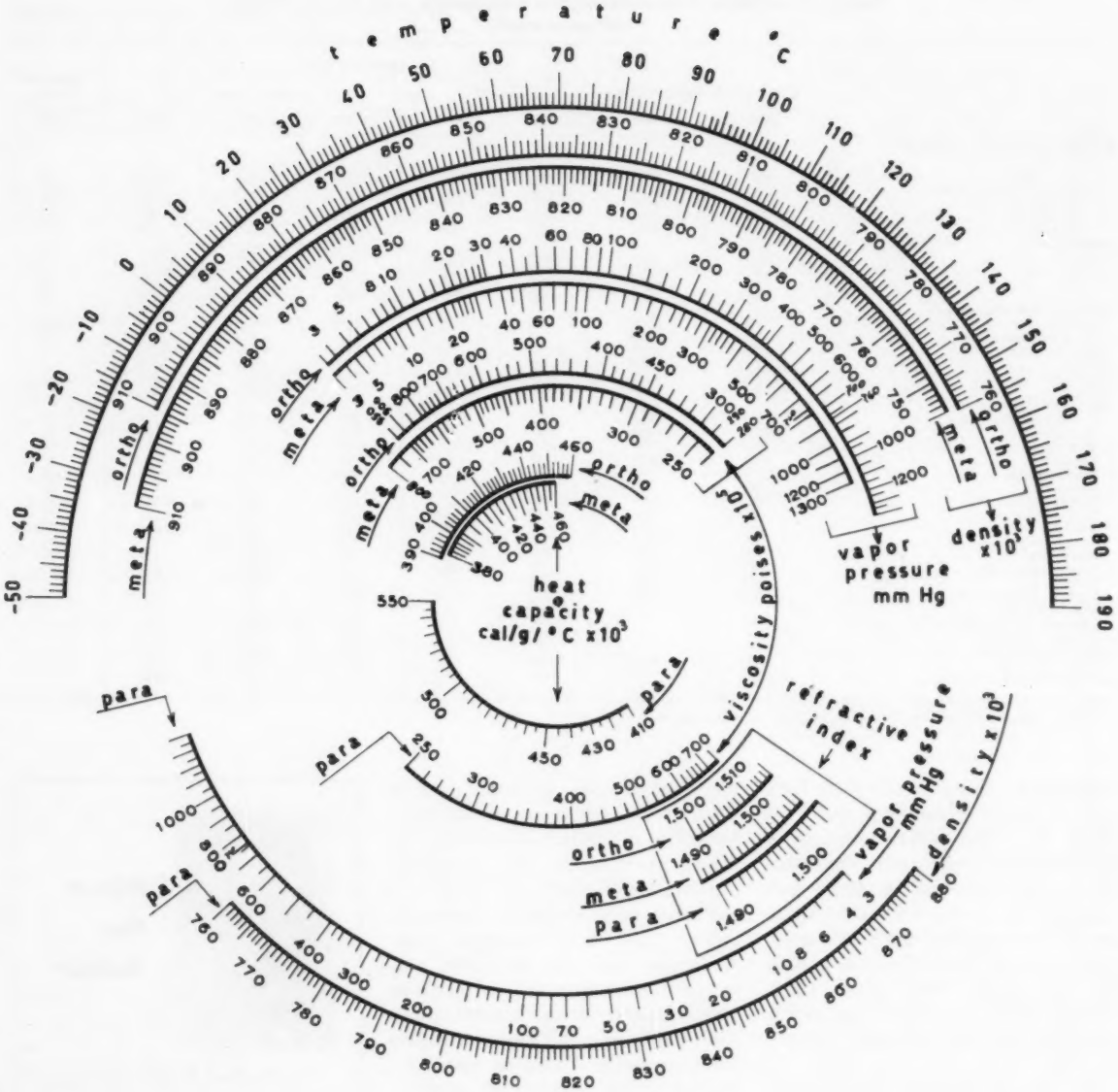
About the Author

Dr. Raphael Katzen graduated from Polytechnic Institute of Brooklyn in 1936 with a B.S. degree in chemical engineering, then received his M.S. degree in 1938 and his Ph.D. degree in 1942, both in chemical engineering from the same school. He gained a great deal of technical experience by working for Cellutate Inc., Northwood Chemical Company, Diamond Alkali, Inc., and Vulcan-Cincinnati, Inc. Early in 1956 Dr. Katzen organized Raphael Katzen Associates International, Inc., which consists of a group of consulting engineers and scientists engaging in consulting activities in petrochemicals and organic chemicals from Canada to Latin America. Presently he is president of this firm which is located in Cincinnati, Ohio.



Physical Properties of Liquid Xylenes

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THIS NOMOGRAPH gives a summary of the physical properties of the three isomeric liquid xylenes. The nomograph has been constructed from literature values. The general arrangement is such that the upper part contains the properties of *o*- and *m*-xylene, and the lower part the refractive index of the three isomers in addition to the properties of *p*-xylene.

The temperature scale holds for both the upper and the lower part of the nomograph.

The nomograph is used as follows: Any line passing through the center intersects the scales in corresponding points. ##

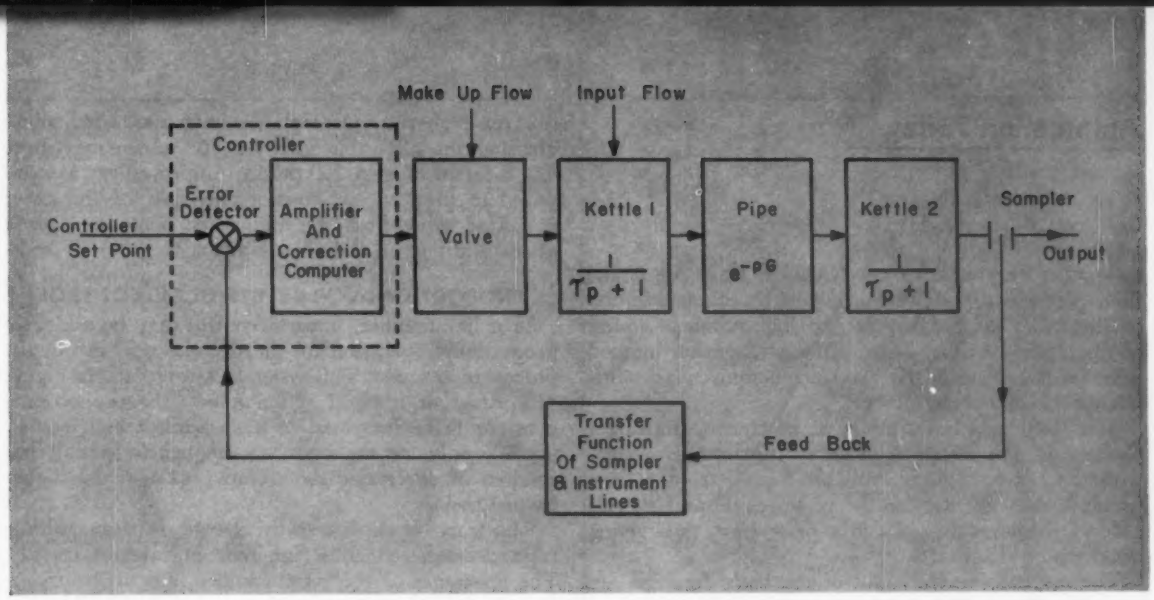

FIGURE 108—To show the value of the Nyquist diagram the illustrative example will be same as used in an earlier part.

PART 17

Automation Today

The Nyquist diagram is used to represent a familiar problem. Now you can see the advantages and disadvantages of this type of representation for studying the response of a process and its control system

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IN THE PREVIOUS TWO ARTICLES of this series (Parts 15 and 16) we have shown some of the advantages and disadvantages of the Nyquist diagram as a means of determining the response of a process and its associated control system. In order to show the relative value of the Nyquist diagram in relation to the Bode diagram which we used earlier, we will illustrate now how the Nyquist diagram can be applied to the same example which we used for the Bode diagram in Part 6.

ILLUSTRATIVE EXAMPLE

Figure 108 sketches the process system whose control will be studied in this example. Two mixing vessels are being used to assure complete mixing of two liquid streams. An output sampler following the second vessel detects the exit composition. This is then compared with the desired value and any error is used to alter the flow of the second stream, B, to achieve the correct composition.

As mentioned before, this system is more complex than is actually required to achieve the desired task, but was devised to furnish a simple, easily described process which still combined a large number of the many possible process functions important for our automatic control study.

A simplified block diagram of the process is shown in Figure 109. Those parts of the process which have negligibly small time constants (i.e., less than one-tenth of the major time constants) have been omitted for clarity. These include all valves, samplers, etc. The resulting block diagram shows the final process under consideration to consist of two first order lags (the two mixing vessels) and a transportation lag or true time delay due to the long interconnecting pipe.

NYQUIST DIAGRAM

Since both kettles are the same size, both T's have the same value. Thus the transfer function of both may be consolidated and represented as $1/(Tp + 1)^2$. The true time delay of the pipe can be represented as e^{-PG}. The Nyquist diagram representing each of these transfer functions was presented in Part 15.

As we have described before, it is a simple matter to determine the total transfer function of the process. By multiplying the individual functions together, the total transfer function is found to be $\frac{e^{-PG}}{(Tp+1)^2}$. Three ways are now open to develop the Nyquist diagram of this total system. First, points from the Nyquist diagram for each part $[1/(Tp + 1)^2, e^{-PG}]$ may be multiplied together to find the new curve, since each of the functions involved is linear. This procedure is illustrated as follows:

If one part gives

$$\theta_1 = 45°, M_1 = 2,$$

and the other part gives

$$\theta_2 = 20°, M_2 = 4,$$

then the multiplication is

$$\theta_3 = \theta_1 + \theta_2$$
$$= 45° + 20°$$
$$= 65°$$

$$M_3 = (M_1)\ (M_2)$$
$$= (2)\ (4)$$
$$= 8$$

Another very common method is to make use of the Bode plot which permits multiplying by simple addition of the functions because of the logarithmical nature of those plots. As the reader can see, this latter method is by far the easier of the two since Nyquist plot multiplication is extremely difficult.

The third and last method is, of course, the direct plotting of the complete transfer function. However, with the Bode diagram available from Part 6, it is a simple matter to transfer the phase angle and magnitude of the several points to a polar plot, thus giving the Nyquist diagram.

The results of such a plot of the basic function are shown in Figure 110. Notice particularly from the expanded view that the curve does not go to zero magnitude at 180° phase shift as would be expected for a normal second order system but instead continues to spiral around the origin. This effect is due to the transportation lag adding a continuously increasing phase lag as the frequency increases. Such an effect is always present when a transport lag is present. This lag does not affect the magnitude of the system.

PROPORTIONAL CONTROL

The addition of a proportional controller to the process results in the Nyquist diagram shown in Figure 111. As can be seen, the outer plot passes through the minus one point. This condition represents the highest proportional gain that is possible for which the system will remain stable. The inner plot results when a gain of 4.25 is used. This provides the desired phase margin of 45° as is indicated on the diagram. Thus the gain must be materially decreased to establish the desired phase margin.

PROPORTIONAL PLUS DERIVATIVE CONTROL

The primary function of derivative control is to speed up the action of a process. Such control also has the auxiliary function of permitting a larger proportional gain to be used in the process control. The Nyquist diagram of a typical derivative controller was presented previously in Part 15. The derivative transfer function is represented by a half circle in the upper right quarter of the diagram as shown in Figure 92 of Part 15.

In Figure 112 the results of adding derivative control to the process are shown. By decreasing the phase shift at higher frequencies, we have succeeded in increasing the allowable gain for 45° phase margin to 8.9, a factor of over 200 percent improvement as compared to proportional control only. Notice the curve is shifted away from the minus one point as a result of the addition of derivative control.

PROPORTIONAL PLUS INTEGRAL CONTROL

In a like manner, integral control may be added to proportional operation to improve the response of the process to an upset. This system is represented in Figure 113. Reset or integral action allows the proportional constant to be increased to 31.5. Such a high gain is possible only for the very low frequencies and it has resulted in decreasing the effective gain at the higher frequencies.

This can be explained by the 10 to 1 magnitude ratio decrease which is inherent in integral control. The operation of the system under integral control is therefore very sluggish in its response. The Nyquist diagram for this mode of control shows that integral control causes the curve of response to be pulled toward the origin, thus resulting in a higher allowable gain.

USE OF ALL THREE MODES OF CONTROL

It is, of course, possible to use all three modes of control on the same process and this is often done. If both derivative and integral networks are combined in one controller, the allowable gain is increased to 75.5. The resulting Nyquist diagram is shown in Figure 114. This is by far the best possible control, because the Nyquist diagram has been pulled in away from the minus one point, while very fast corrective action is still possible with excellent stability.

USE OF THE M CIRCLE

Situations often arise when it is necessary to determine only the closed loop gain required for a good transient response. In this case the use of the M circle described in Part 16 is a major aid in obtaining the correct value of this gain.

The usual procedure used in obtaining the correct gain as described in Part 16 requires the trial use of various possible values of gain on the Nyquist diagram until the phase shift-magnitude locus curve passes through the unit circle representing a unity gain at a phase margin of 45°. We will now discuss a more direct method of determining a design criteria for a good transient response which can be very helpful in solving the problem.

For any Nyquist diagram which may be plotted, it is possible to construct a set of M (or constant magnitude) circles. That M circle which becomes just tangent to the system curve is the value of maximum M. This maximum M specifies the amount of overshoot which will be obtained if and when the system is subjected to a step input. The reader can see that the selection of a maximum M circle can be the basis of a design criteria instead of the phase margin as was discussed earlier in the article. A range of maximum M of from 1.1 to 1.6 is considered to be

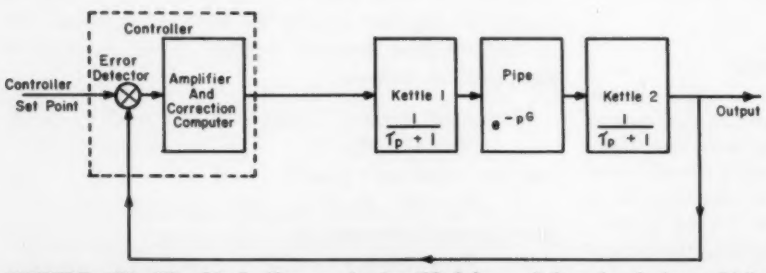


FIGURE 109—The block diagram is simplified by omitting the devices which have relatively small transfer functions.

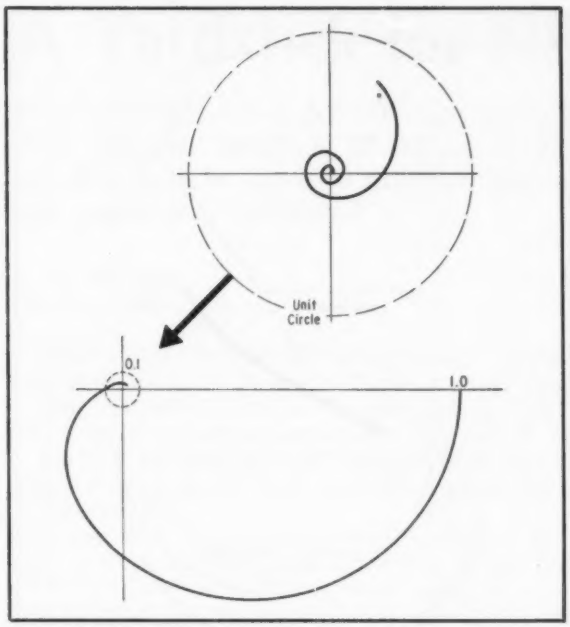


FIGURE 110—The curve does not go to zero at 180° phase shift as would be expected for a normal second order system.

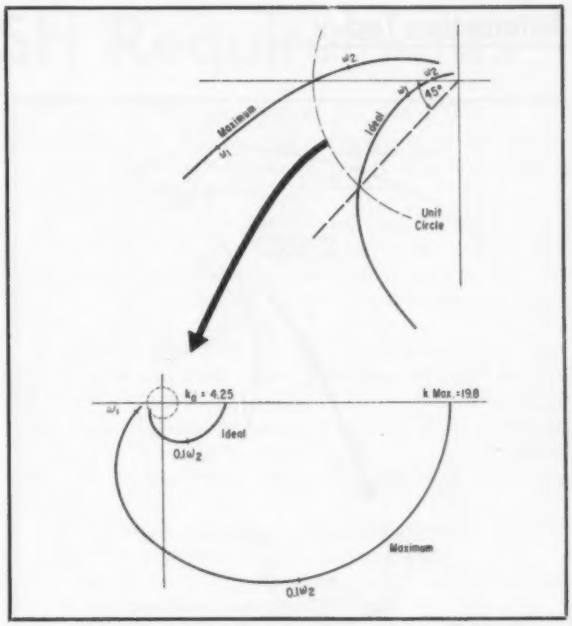


FIGURE 111—The outer curve shows the highest proportional gain that is possible for which the system will remain stable.

a good design practice because any value within this range will yield a satisfactory transient response. Let us now derive our graphical method.

The magnitude ratio of the output to the input of any control system with a direct feedback is $M = \left|\frac{G(p)}{1+G(p)}\right|$. Since G(p) is a complex quantity, then $G(p) = \sigma + j\varnothing$ where σ = the real part and $\varnothing$ = the imaginary part of G(p). Thus

$$M = \left|\frac{G(p)}{1+G(p)}\right| = \left|\frac{\sigma + j\varnothing}{1+\sigma+j\varnothing}\right| = \sqrt{\frac{\sigma^2+\varnothing^2}{1+2\sigma+\sigma^2+\varnothing^2}}$$

Squaring the terms of the last form and rearranging the equation, we obtain

$$\left[\sigma - \frac{M^2}{1-M^2}\right]^2 + \varnothing^2 = \left(\frac{M}{1-M^2}\right)^2$$

Through the use of the principles of analytical geometry, it can be shown that the above equation represents a circle with a radius of $M/(1-M^2)$ and one which has its center on the real axis at the point $M^2/(1-M^2)$.

Consider the example M circle which has been sketched in Figure 115. Construct the line $\overline{OA}$ from the origin tangent to the circle at point T. Defining the properties of the angle ψ and the location of the circle, we see that the $\sin\psi = \frac{\overline{PT}}{\overline{OP}}$. But the line $\overline{PT}$ is also the radius of the circle or equal to $M/(1-M^2)$. The line $\overline{OP}$ specifies the location of the center of the circle at $M^2/(1-M^2)$.

Thus the $\sin\psi$ equals $\frac{M/(1-M^2)}{M^2/(1-M^2)}$ which equals $\frac{1}{M}$.

Furthermore, it can be proven that the point C is located at $-1+jO$ for all M circles. From these facts we have set the conditions for a simple graphical method of constructing M circles. The procedure also is covered in the literature.[1]

The procedure for constructing a given M circle is carried out stepwise as follows: Referring to Figure 115, first construct the line $\overline{OA}$ at an angle ψ_1, so that the $\sin\psi_1$ equals $\frac{1}{M_1}$. In this case M_1 is the desired value of maximum M. Next draw the vertical line $\overline{CT}$ through the $-1+jO$ point. This latter line determines the point of tangency (T) of the M circle. All that remains then is to draw the circle tangent to the line $\overline{OC}$

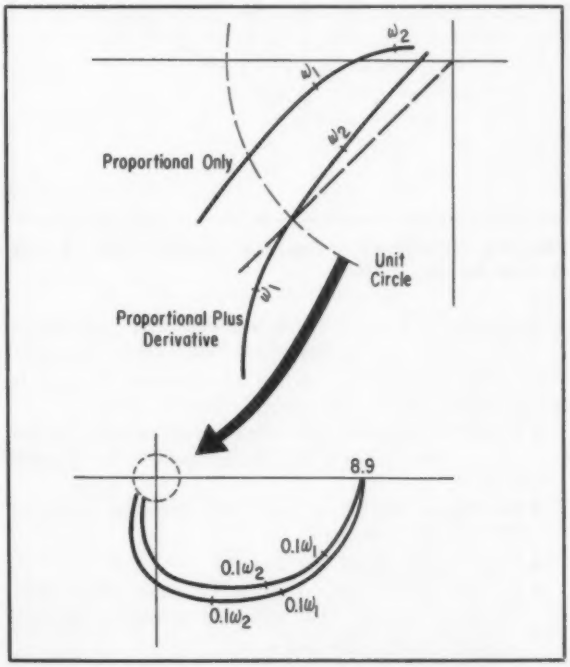


FIGURE 112—Both proportional and derivative control can be used on a system.

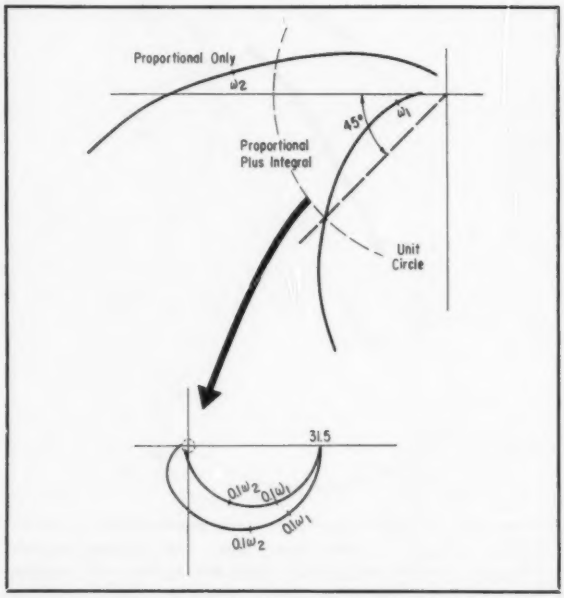
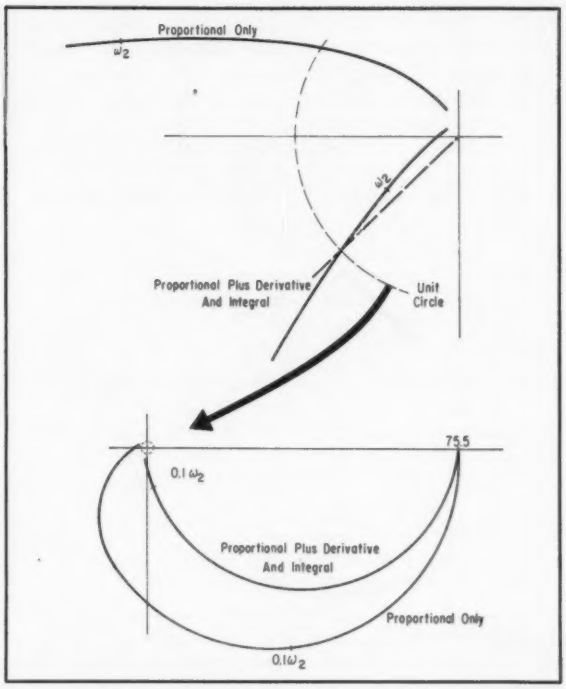


FIGURE 113—Integral control can be added to proportional control to improve the response of the process to an upset.



FIGUURE 114—The best control is achieved by combining all three types of control.

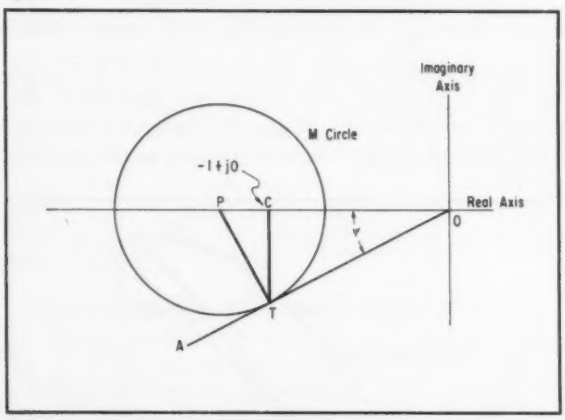


FIGURE 115—Simple geometrical relations make it easy to construct the M circle.

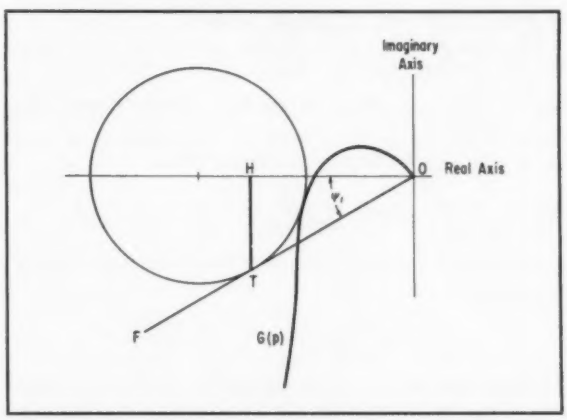


FIGURE 116—The M circle is a major aid in estimating the correct gain for a closed loop control system.

at the point T. For any given function, G(p), the locus of G(p) must also be tangent to this same M circle.

Summarizing these steps we can formulate the following procedure for determining the M circle:

- Draw the G(p) Nyquist locus on the complex plane for a value of open loop gain equal to 1. (Figure 116)
- Determine the angle ψ_1 for the specified value of M (i.e., M_1) desired.
- Knowing ψ_1, draw the line $\overline{OF}$.
- By trial and error, construct a circle which has its center on the real axis and which is tangent to *both* the line $\overline{OF}$ and G(p).
- Draw the vertical line $\overline{TH}$ from the point of tangency (T) with the line $\overline{OF}$ to the real axis. Find the number K such that K times $\overline{OH}$ equals unity. The value of K thus determined is the gain which is necessary to be used with G(p) to yield the original maximum closed loop M originally chosen. One may now replot the Nyquist diagram for the new value of gain. However, this is not really necessary since the design criteria has already been satisfied.

The M circles are useful for the development of other criteria as well as those discussed in this article. The use of M circles in transient analysis and frequency response will be discussed in future articles of this series.

LITERATURE CITED

[1] Chestnut, Harold, and Mayer, R. W., *Servomechanisms and Regulating Systems Design*, Vol. 1, John Wiley & Sons, Inc., New York, 1951.

TO BE CONTINUED

A Yardstick for NPSH Requirements

Does oil require less NPSH than water? Two common methods of taking credit are shown to be open to question and a new method is presented

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NPSH IS NET POSITIVE suction head. In its simplest form, it can be pictured in Figure 1. Pure water is being pumped at 212.00° F. The atmosphere is 14.696 psia, which is the boiling point of pure water at 212° F.

The flow has been gradually increased until there is some cavitation or the head curve of the pump shows a detectable drop.

A glass tube rising vertically from the suction line, open to the atmosphere, shows the water level standing 10.00 feet above the center line of the pump. At some spot in the pump, the pressure has dropped to 14.696 psia and the water is vaporizing slightly.

All of the 10.00 feet of static has been used up at some point inside the pump. But, in addition, the pump has used up a little more than this. The liquid in the suction line has energy of motion, called kinetic energy. This has been used also. The formula for this energy, in feet, is

$$\text{Kinetic Energy} = \frac{(\text{Velocity})^2}{2 \times g} = \frac{V^2}{64.4}$$

Since the water is moving at 6.0 ft./sec., its kinetic energy is

$$\text{KE} = \frac{(6)^2}{64.4} = 0.56 \text{ feet}$$

The NPSH required is, therefore:

$$10.00 + 0.56 = 10.56 \text{ feet}$$

The case just described is the simplest. To cover all cases, the definition has to be a little more technical.

General Definition. NPSH is the total net energy (static and kinetic) in the suction pipe, above the vapor pressure of the liquid, required to maintain pump total head. Reference point is usually the center line of the pump shaft (for vertical pumps it is usually center line of suction). Sometimes a certain deviation is allowed from the total head.

The NPSH is computed as follows:

- Read pressure in suction line—convert to feet of liquid.
- Compute velocity in suction line. Kinetic energy (Ft.) $= \frac{V^2}{64.4}$.
- Add (1) and (2) to obtain gross suction energy.
- From temperature in suction line, obtain vapor pressure and convert to feet of liquid.
- Subtract (4) from sum of (1) and (2).
- Correct for difference in elevation of center line of suction and center line of pump. If suction line is lower, you subtract.

All this may appear complicated, but it is used in the customary factory test. Figure 2 shows the set-up. The pump to be tested takes suction from a tank or pit. The pump and piping are filled with water—the foot valve prevents runback to the pit.

A series of points of various flow rates are run. Say, 300 gpm is one such point. This flow is held constant by the flow control. The suction valve is gradually closed until there is some evidence of cavitation. It might be by sound or it might be by a drop in the capacity curve (the capacity curve has already been run with wide open suction).

The following readings and computations are made:

1. Suction temperature 80° F., conversion factor psi to feet of water	=	2.314 ft./psi.
Vapor pressure from steam tables 0.5068 psia × 2.314	=	1.173 ft.
2. Suction gage 5.58 psia × 2.314	=	+12.92 ft.
3. Suction gage is 6 inches below center line of pump		— 0.50 ft.
4. Pressure in suction at pump center (2) + (3)	=	12.42 ft.
5. Velocity of liquid, 4-inch line, 300 gpm	=	8.025 ft./sec.
Kinetic energy = $\frac{(8.025)^2}{64.4}$	=	+ 1.00 ft.
6. Gross energy in suction (4) + (5)		13.42 ft.
7. Less vapor pressure		— 1.17 ft.
8. NPSH. (6) — (7)		12.25 ft.

From a theoretical point of view, the methods of Figures 1 and 2 can be considered equal. But there are some very important practical differences. In Figure 2, the water contains dissolved air, but in what degree of saturation no one knows. However, we do have considerable data on pumps tested by Figure 2.

Data by Figure 1, with pure deaerated water, appear to be completely missing. There are a few data taken on hot water, but the tank was still exposed to air. Undoubtedly much of the air was eliminated, but it takes more than simple heating to remove it. Look at the design of deaerators for boiler feed water which still leaves a trace.

Tests are run occasionally where vacuum is applied to the suction tank. Undoubtedly, this also removes a large percentage of the air, but certainly not completely.

Unfortunately it is human to think of the perfect method when we actually have data taken from an imperfect, though very practical, method. It might help to use more

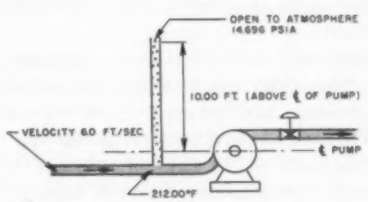

FIGURE 1—NPSH in its simplest form.

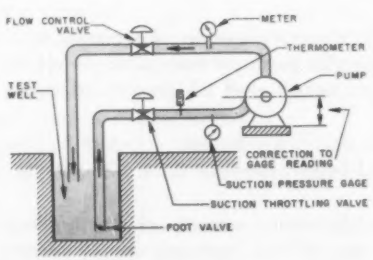

FIGURE 2—Standard factory test set-up to find NPSH.

A Yardstick for NPSH Requirements . . .

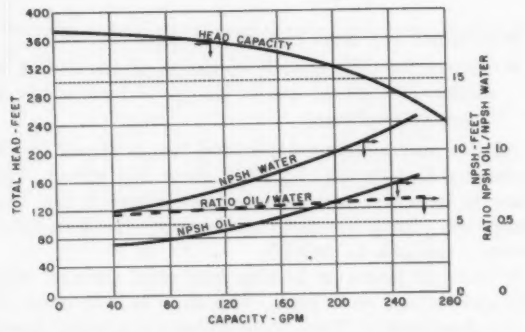

FIGURE 3—This performance curve was quoted last year.

exact names. Call data from Figure 1 *Absolute NPSH*, and from Figure 2 *Open Cold Water NPSH*.

NPSH Requirements For Other Fluids. For years there has been a widespread belief in the petroleum industry that "hydrocarbons require less NPSH than water." Several types or methods of determining NPSH corrections for hydrocarbons have been used. Several pump manufacturers have used a straight multiplier for all hydrocarbons.

Figure 3 shows a performance curve on this basis—quoted about a year ago. One curve of NPSH is for water, presumably *Open Cold Water*. A second is marked *Oil*. This is an almost constant fraction (0.6) times the water curve. No qualities or conditions for the oil, such as pressure, temperature, gravity, etc., are specified.

Actually, Figure 3 is for a pump taking hot lube-oil from a vacuum tower. But pumps for other duties, such as cold gasoline at atmospheric pressure, have about the same ratio between NPSH for oil and for water.

However—perhaps luckily—it is doubtful that such oil NPSH curves have been used very often in actual installations. Certainly the pump manufacturers have never claimed that these oil NPSH curves were anything more than what they are, but such curves are potentially dangerous. Some engineer who doesn't know their background might use them. They should be eliminated from standard performance charts.

Another method is suggested by the Standards of the Hydraulic Institute. Figure 4 is a reproduction of its chart. This chart assumes that the actual specific gravity (under pumping conditions) and pressure determine a multiplier for water NPSH to obtain NPSH for the hydrocarbon pumped.

Some variables are not included directly, such as (1) slope of vapor pressure, (2) vapor density, (3) latent heat, (4) specific heat. Some of these go along to some extent with pressure. At any rate, reasonable results would be obtained for the low gravity region. However, the influence of specific gravity is in reverse to what it should be. A better form of line is demonstrated by lines A and B. These are plotted on the assumption that the 0.35 specific gravity points would be correct.

Actually, the dangerous area is at high specific gravity. For example, a heavy crude being pumped from a 5 psig (20 psia) receiver after the crude has been flashed from a higher pressure would read 85 percent of water NPSH. This would invite trouble.

One pump manufacturer uses a chart that is a variation of Figure 4. The main difference is that at 14.7 psia, and below, the reading is 100 percent.

Mathematical Analysis. A strictly mathematical analysis of the problem will now be made. If the mathematics are difficult, concentrate on understanding (1) the fundamental picture, (2) the assumptions made, and (3) the final chart. For the mathematical derivation, see box.

The fundamental picture is shown in Figure 5. The picture at the top shows liquid flowing in a converging pipe from left to right. Pressure at Point A is well above the bubble point. At Point B, the pipe starts to neck down, hence, the velocity starts to increase. Pressure has to drop in order to supply the added energy of velocity (increase of kinetic energy). This continues until, at Point C, the pressure has dropped to the bubble point. Between C and D, more and more vapor is formed.

The temperature remains constant from A to C. Then, the vapor formation requires heat (latent heat). Assume that this heat comes from the liquid. The only way the liquid can give up heat is by a drop in temperature (sensible heat). Of course, this is not *exactly* true. But remember only a very small *weight* percentage of the liquid turns to vapor. Hence, heat demand is small. It is all well within the accuracy needed.

The eye of the impeller is somewhere near Point D. The region beyond Point D is far enough inside the impeller so that the pump is supplying all the added energy. None comes from the pressure in the suction line. The vapor will liquefy as the pressure goes up. At any rate, Point D is the point of maximum vapor.

The drop in pressure between Points C and D is called Suppression Head and is represented by the symbol Δh. This is customarily in feet of liquid because it

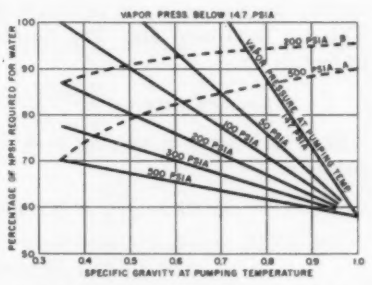

FIGURE 4—The hydraulic institute suggests these curves for NPSH correction.

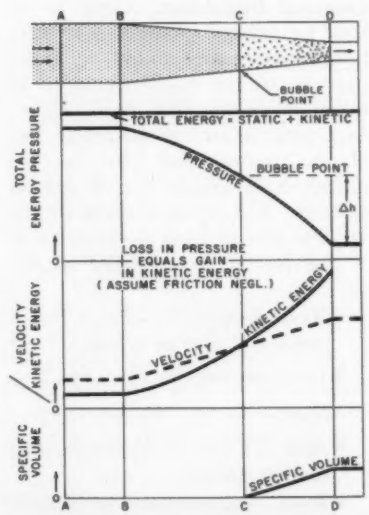

FIGURE 5—Liquid is flowing in a converging pipe.

puts all liquids on a common basis (equal Δh give equal increase in velocity for all liquids).

$$\Delta h = \left(\frac{144}{\rho_1}\right)\left(\frac{P_1 - P_2}{T_1 - T_2}\right)(V)\left(\frac{\rho_v}{\rho_1}\right)\left(F + \frac{H}{100\,C_p}\right) \quad (1)$$

Δh = Suppression in pressure below initial bubble point in ft. of liquid.

F = Slope of initial vaporization, °F/wt. percent vapor. For example, a mixture might start to vaporize at 100° F and be completely vaporized at 200° F. Then $F = (200\text{-}100/100) = 1.0$. For pure components $F = 0$.

H = Latent heat, Btu/pound.

C_p = Specific heat of liquid.

V = Actual cubic feet of vapor formed per 100 cubic feet of liquid.

$\frac{P_1 - P_2}{T_1 - T_2}$ = Slope of vapor pressure curve, psi/°F, taken at point of operation.

ρ_v = Density of vapor, pound/cubic feet.

ρ_1 = Density of liquid, pound/cubic feet.

If you examine equation (1) carefully, you will see that for any set point of pressure and temperature, it boils down to:

$$\Delta h = \text{a multiplier times } V \quad (1a)$$

This means that, if we double V, we get double the value for Δh. The value of V must always be known to solve for Δh.

How much vapor can a pump stand? There isn't much to go on; however, there is a little. Some engineer with a pump company told me that they had injected air in a pump suction up to 3 cubic feet 100 cubic feet of water without noticeably harming performance. Other pump engineers have agreed that this is a reasonable figure.

It is agreed that such information is not scientific. But suppose we pick 2 cubic feet per 100 cubic feet of liquid. All the pump engineers I've talked to think that this is quite safe. To be sure, different pumps must act differently, and the limit must change throughout capacity for any one pump. But it will be some time before we get such data.

To show how all this might be applied, look at an example. Suppose we plan to pump pure propane at 200 psia. From Fig. 6A, we read $\Delta h = 3.2$ feet.

The drum from which we will pump has a liquid level 10 feet above the centerline of the pump (after deductions for line friction).

For zero vapors at the eye, the NPSH needed would be $10 + 3.2 = 13.2$ feet. The factory will test on cold water. On Figure 6B, the lowest reading for water at 4.5 psig is $\Delta h = .001$ feet for 2 cubic feet of vapor at the eye. This corresponds to about 150° F. The test will certainly be run at 100° F or less.

The correction for water is infinitesimal. Therefore, we would specify that the pump must not require more than 13.2 feet of NPSH under water test.

We should also call attention to the fact that we have said nothing about damage to the impeller from cavitation. That is another problem. Actually, most engineers would not plan on allowing any vaporization at design load. But most of them put a fair "pad" in the specified capacity. Therefore, the pump manufacturer quotes an NPSH that already has a factor of safety. Hence, the formula might be used to prevent doubling the factor of safety.

Another use is in analyzing data or in trouble shooting. I have used this formula several times to throw out some erroneous conclusions.

Figure 6 gives the computed suppression when 2.0 cubic feet of vapor are formed per 100 cubic feet of liquid. If other values of vapor are desired, simply multiply by the ratio of V/2.0.

Figure 6 is probably most useful in clearing up a few ideas we have had. In the first place, the correction is a straight subtraction and *not* a multiplier, as supposed. Nor do the various hydrocarbons have the same value at the same pressures. We expect water to have a different value, which it does.

Notice also the extremely small suppressions at low pressures. Even if we assume enormous amounts of vapor, the computed suppression is not measurable. Yet open cold water tests often show a small amount of drop in the total head curve before the final sudden drop. This is a proof of dissolved air, I believe.

Some have advanced the idea of what might be called delayed vaporization, a sort of supersaturation. Yet cavitation tests on models, using water, show that the bubbles form and collapse in a few thousandths of a second.

Of course, the same tests are not reported on hydrocarbons, but we know that where hydrocarbons at bubble point pass through a throttling valve, enough vapor forms in one one-hundredth second to form frost on the valve and also to affect the valve capacity.

PART II

Pumping Liquids Containing Dissolved Gases. This problem concerns engineers and operators of the various types of petroleum plants *directly* in the following:

(a) Pumping from atmospheric tanks, tankers, barges, tank trucks, etc.

(b) Pumping from tanks that are pressured with gas of some sort.

(c) Pumping from bottoms of steam strippers.

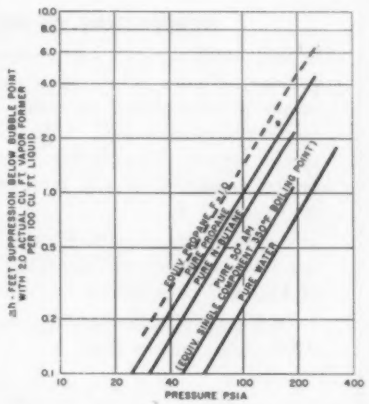

FIGURE 6a—Computed suppression below bubble point for 2.0 cu. ft. vapor per 100 cu. ft. liquid. High pressure range.

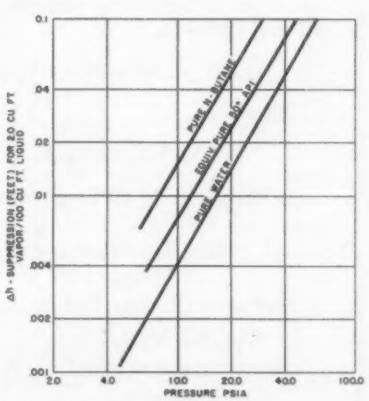

FIGURE 6b—Low pressure range.

The subject also concerns them indirectly because it is involved in the NPSH tests used at the pump factory.

Air dissolves in hydrocarbons to a much higher degree than it does in water. We do not hear of this making trouble in the refinery. True, many products go to atmospheric tanks. But these tanks are filled and emptied from the bottom. This prevents contamination by air to a great extent. But take other situations. In airplanes, the fuel has to be exposed to the air, and the liquid is certainly sloshed around so that good contact with air is provided. As the airplane attains altitude, what may have been partial saturation at ground level becomes complete saturation at high altitude. In tankers, the liquid is certainly exposed to air, and the rolling of the ship gives good mixing and contact.

Such cases have caused real headaches in pumping. Let us take a case where 100 octane gasoline was pumped. Brown and Bower[1] found that such fluid had 4.5 to 7.0 psi higher true vapor pressure than obtained by what is called the Reid method. Curve D of Figure 10 is a replot of one of their curves.

Some information is missing, but we can piece together a fair picture. Certainly we can be sure from the picture of the test set-up that the gasoline was exposed to air. We can also be reasonably sure that it did not contain methane, ethane or propane. The process of making aviation fuel eliminates these—and probably most of the butane.

Furthermore, if some of these were not removed, they would show up in the Reid type vapor pressure test that was made. In order to make some kind of comparison, I computed Curve C_1. In order to avoid extremely difficult complications, I had to assume a pure single component having a vapor pressure of 6 psia at 73.5 F. I assumed saturation with air at 14.696 psia and 73.5 F. The solubility of nitrogen was obtained from NGAA equilibrium curves. Oxygen is guessed at—guided by data for water.

Curve C_2 is a reference curve for the hydrocarbon of Curve C_1, but absolutely free of air. While my method of comparison is not too scientific, it does bring out for sure that the sample of Curve D was not fully saturated with air.

It might be well to take an example of what might happen to a design engineer. The pump manufacturer might quote a pump for 6 feet NPSH to pump the gaso-

DERIVATION OF FORMULA

Start with the case for a pure liquid (one component). Figure 7 shows an enlarged section of the vapor pressure curve. Assume a straight line between points A and C. This isn't as inaccurate as might appear. Usually the temperature drop between A and C is not more than 5 F.,—sometimes only 1 F.

Figure 7 ties in with Figure 5. Point A of Figure 7 corresponds to Point C of Figure 5. Point E of Figure 7 corresponds to Point D of Figure 5.

In Figure 7, triangle ADE is similar to triangle ABC which means that

$$\frac{P_1 - P_2}{T_1 - T_2} = \frac{P_1 - P_m}{T_1 - T_m} \qquad (2)$$

The heat used up in vaporization is

$$V\rho vH \qquad (3)$$

And this is assumed as coming from sensible heat of the liquid

$$100\,\rho_1 (T_1 - T_m)\,Cp \qquad (4)$$

Therefore

$$V\rho vH = 100\,\rho_1 (T_1 - T_m)\,Cp \qquad (5)$$

Writing (5) in different form

$$T_1 - T_m = \frac{V\rho vH}{100\,\rho_1 Cp} \qquad (6)$$

Substituting (6) into (2)

$$\frac{P_1 - P_2}{T_1 - T_2} = \left(P_1 - P_m\right)\left(\frac{100\,\rho_1 Cp}{v\rho vH}\right) \qquad (7)$$

$$\text{But } \Delta h = (P_1 - P_m)\left(\frac{144}{\rho_1}\right) \qquad (8)$$

$$\text{or } (P_1 - P_m) = \frac{\Delta h \rho_1}{144} \qquad (8a)$$

Substituting (8a) into (7)

$$\frac{P_1 - P_2}{T_1 - T_2} = \frac{\Delta h \rho_1}{144}\left(\frac{100\,\rho_1 Cp}{v\rho vH}\right) \qquad (9)$$

$$\text{or } \Delta h = \left(\frac{144}{\rho_1}\right)\left(\frac{P_1 - P_2}{T_1 - T_2}\right)\left(\frac{V\rho v}{\rho_1}\right)\left(\frac{H}{100\,Cp}\right) \qquad (10)$$

which is (1) with F = 0

Mixtures. We will now take the more complicated case for mixtures. Start with Figure 8A. This shows how a mixture vaporizes under various pressures. P_1 is the pressure at Point C of Figure 5—P_m is Point D of Figure 5.

Figure 8B is an enlargement of the box in Figure 8A. The pressure lines P_1, P_m, P_2 are assumed parallel for the short interval involved. Figure 9 gives the vapor pressure. Line AC is at bubble point (zero vapor). Line DF is for V cubic feet/of vapor/100 cubic feet of liquid.

These two lines are also assumed parallel for the small interval involved.

On Figure 9 triangles ABC and DEF are similar, i.e., corresponding sides are proportional. Therefore

$$\frac{P_1 - P_2}{P_1 - P_m} = \frac{T_1 - T_2}{T_3 - T_m} \qquad (11)$$

line of Curve D. And who ever furnished the gasoline would follow the custom of the industry and would tell him that the vapor pressure at pumping temperature was 6 psia. So the engineer would take 6 feet and divide by 3.0 ft./psi (for gasoline) to get 2 psi. This, added to 6.0, gives 8.0 psia that would be needed at the pump nozzle to have it work properly. In other words, he would allow 6 feet of liquid above the supposed vapor pressure at the pump intake.

But suppose that the gasoline had some air dissolved. If partially saturated as per Curve D, 10 cubic feet of vapor would be formed per 100 cubic feet of liquid—and it still hasn't reached the eye of the impeller.

It could be worse. If thoroughly saturated by transportation per example, it might follow something like Curve C_1. Then, over 100 cubic feet of vapor would form per 100 cubic feet of liquid at 8 psia at pump intake. Certainly, someone would be in trouble.

An actual case[2] of pumping absorption oil falls right into a similar situation. The pump used required 6 feet NPSH by open cold water test at 80 gpm. On absorption oil, this meant that the pump should work with 2.35 psia at the suction nozzle. Yet at 11.5 psia, it reached cavitation.

Another way of looking at it, 30 feet NPSH was required with absorption oil as against 6.0 feet for cold water. It is almost a certainty that dissolved air was the cause of this discrepancy. The absorption oil was transported to the test site by truck. It was loaded and unloaded. Both these actions increase air contact. And the oil was exposed to air during test.

Some interesting data[3] on jet fuel are given on Curves B_1, B_2 and B_3 of Figure 10. These curves represent true vapor pressure taken in the laboratory. B_1 and B_2 are for samples thoroughly saturated with air. It looks as though the sample used in Curve B_1 was saturated at a lower temperature than 100° F because its bubble point is higher than atmospheric pressure.

The sample for B_3 was thoroughly deaerated before it was placed in the true vapor pressure device. While these curves hardly fit into refinery problems, they are quite valuable information. We know for certain the degree of saturation.

There was another interesting case of apparent high NPSH where a pump handled an amine solution. The solution contained carbon dioxide in chemical combination. However, the carbon dioxide could be liberated

This can be written

$$\frac{P_1 - P_2}{T_1 - T_2} = \frac{P_1 - P_m}{(T_3 - T_1) + (T_1 - T_m)} \quad (12)$$

As for a pure substance

$$V\rho vH = 100\,\rho_1\,(T_1 - T_m)\,Cp \quad (5)$$

and

$$T_1 - T_m = \frac{v\rho vH}{100\,\rho_1\,Cp} \quad (6)$$

Also from Figure 8B

$$F = \frac{T_3 - T_1}{V\rho_v/\rho_1} \quad (13)$$

or $$(T_3 - T_1) = F\frac{V\rho_v}{\rho_1} \quad (14)$$

Substituting (14) and (6) in (12)

$$\frac{P_1 - P_2}{T_1 - T_2} = \frac{P_1 - P_m}{F\frac{V\rho_v}{\rho_1} + \frac{v\rho vH}{100\,\rho_1 Cp}} \quad (15)$$

and as before

$$P_1 - P_m = \frac{\Delta h \rho_1}{144} \quad (8a)$$

Substituting 8a in (15) and rearranging

$$h = \left(\frac{144}{\rho_1}\right)\left(\frac{P_1 - P_2}{T_1 - T_2}\right)\left(\frac{V\rho_v}{\rho_1}\right)\left(F + \frac{H}{100\,Cp}\right) \quad (1)$$

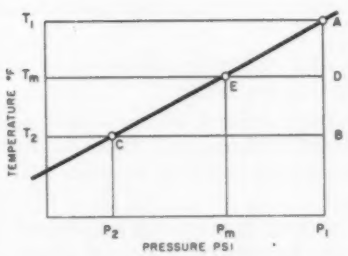

FIGURE 7—Vapor pressure curve (top left) for pure, one component liquid.

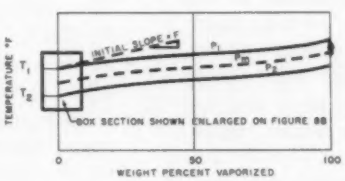

FIGURE 8a—These curves (top center) show how a mixture vaporizes under various pressures.

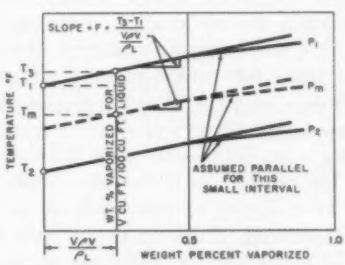

FIGURE 8b—Box from Figure 8a enlarged (top right).

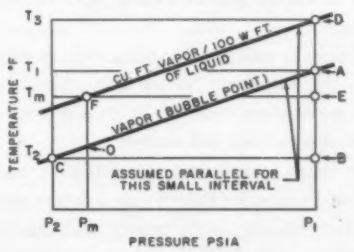

FIGURE 9—Vapor pressure of mixture with vaporization (right).

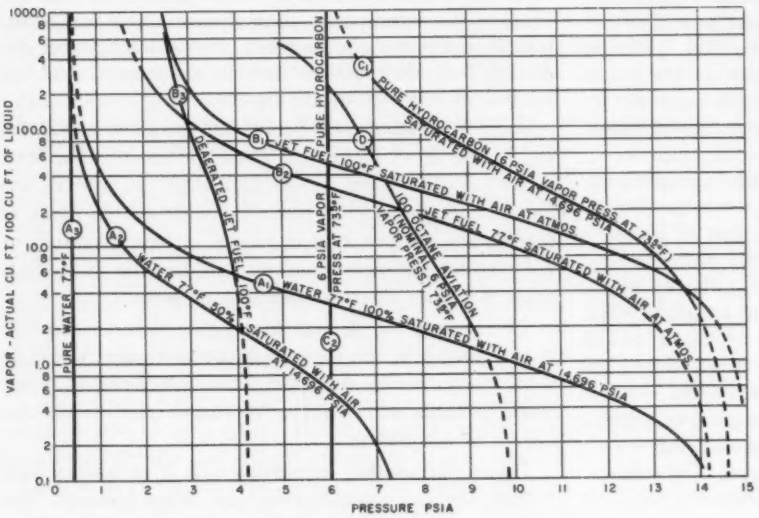
VAPOR - ACTUAL CU FT/100 CU FT OF LIQUID
PRESSURE PSIA
PURE WATER 77°F
PURE HYDROCARBON 6 PSIA VAPOR PRESS AT 73°F
(C1) PURE HYDROCARBON 15 PSIA VAPOR PRESS AT 73°F SATURATED WITH AIR AT 14.696 PSIA
(B1) JET FUEL 100°F SATURATED WITH AIR AT 14.696 PSIA
(B2) JET FUEL 77°F SATURATED WITH AIR AT ATMOS.
(A1) WATER 77°F 100% SATURATED WITH AIR AT 14.696 PSIA
(A2) WATER 77°F 50% SATURATED WITH AIR AT 14.696 PSIA
DEAERATED JET FUEL 100°F
100 OCTANE AVIATION (VAPOR PRESS 6 PSI) 73°F
(C2)

FIGURE 10—Equilibrium vaporization of various liquids.

About the Author

Art Whistler is a process consultant for The Fluor Corp., Ltd., Los Angeles, where he is an advisor in the Process Department. Holder of a B.S. degree in engineering and physics from California Institute of Technology, he was with C. F. Braun & Co. from 1926-48. He was Braun's chief engineer for five years, and a process consultant for two years. Whistler joined Fluor in1948, and was chief process engineer there from 1951-55.

into solution if given time and some degree of temperature.

The solution flowed from the regenerator through exchangers and was pumped before final cooling. This provided time and a fair degree of temperature. The pump required an apparent NPSH of some 30 feet, whereas an open cold water test showed some 11 feet. The solution to the problem was a slow speed booster ahead of the main pump.

The booster requires very little NPSH. It may have had cavitation, but it did not register. The main pump ruined itself in a few days since it had a 200-hp motor. The booster had a 15 hp motor. Without doubt the damage done is related to the power.

Curve A_1 is computed for water, assuming 100 percent saturation at atmospheric pressure. Henry's law constant was used for nitrogen and oxygen. Curve A_2 assumes 50 percent saturation. Unfortunately, we run into a real snag when we try to apply these curves to cold water tests. We don't know the degree of saturation, and we don't know how much vapor the impeller will handle.

We can speculate a little, however. We know that we get apparent NPSH's of 6 to 12 feet in certain pumps during open cold water tests. This means (for 77 F.) that the pressure in the suction nozzle was 3 to 6 psia. But what degree of saturation do we use? We might try 50 percent. Then we would have 0.55 to 3.5 cubic feet of vapor per 100 cubic feet of liquid *at the pump nozzle.*

There is still some pressure drop required to get flow into the impeller. So we have another big guess. It is one guess after another. With our present state of knowledge, we cannot get answers.

It takes a different approach. A good one would be to use Figure 1 (Part I) as a setup using boiling water. Positive boiling, both before and during the test, would eliminate air. NPSH is best measured by varying the height in the suction tank. This would not tell us how much vapor formed in the impeller. But the measured NPSH would be very close to the absolute NPSH.

If we look at Figure 6B (Part I), we see that .008 foot suppression gives 2 cubic feet per 100 with water at 14.7 psia (212 F.). Thus, 20 cubic feet per 100 would require 0.08 foot, and 80 cubic feet per 100 would require 0.32 foot. We should certainly get very close to the absolute value of the NPSH.

Of course, we are not going to get all this nice data very soon. And even if we had them, we still do not always know what we are pumping. In the meantime, we have to design pump installations. Each of us will probably work out his own set of general rules and apply judgment in special cases. We might write down this set of suggested rules:

- Take open cold water NPSH tests as absolute. True, they may contain safety factors, but maybe less than we think.
- If we know what we are pumping, use Figure 6 (Part I) in taking less NPSH.
- In pumping from refinery atmospheric storage where filling and withdrawal is from the bottom, use a vapor pressure half way between 14.7 and Reid type.
- In pumping oil from a steam stripper, assume oil is at boiling point. Remember that steam dissolves in oil too.
- In pumping from tankers, tank trucks, etc., where contact with air is accelerated, assume saturation. Specially designed or selected pumps or boosters may be needed.

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[1] Bower, Clark D. and Brown, Perry H., "Prediction of Suction Limitations When Pumping Volatile Liquids," Joint meeting Southern California sections of Natural Gas Association and ASME, April 1, 1943.

[2] Hendrix, Lloyd T., "The Determination of Hydrocarbon NPSH Characteristics," California Natural Gasoline Association, October 10, 1957.

[3] Personal Communication with Aerojet Corp.

Figure Octanes of Blends This Way

All you need to know are the paraffin plus naphthene concentration and the octane rating of each component to figure blend octanes by this method

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THE PREDICTIONS of octanes for gasoline blends by some existing methods are not satisfactory when one or more of the components is rich in aromatics. Presented here is a new method for calculating the unleaded Research octane numbers of such blends.

The new method considers a blend to be made of two portions—one containing the aromatic and olefin components while the other contains the paraffin and naphthene fractions. The blending octane number of the aromatic-olefin portion is related to the blending octane number and concentration of the paraffin-naphthene portion. The correlation is presented in a graphical form, and it is necessary only to know the paraffin-naphthene concentration and octane rating of the components in order to predict the octane of a blend.

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HOW THE CORRELATION IS DEVELOPED

The blending octane numbers are defined for two fractions of a gasoline so that these numbers will fulfill

TABLE 1—Summary of Characteristics of Blend Components

Blend No.	COMPONENT 1			COMPONENT 2			COMPONENT 3			COMPONENT 4			COMPONENT 5			BLEND		CALC. F-1 CLEAR OF BLEND	
	Vol. % In Blend	F-1 Clear	Vol. % A-O	Vol. % In Blend	F-1 Clear	Vol. % A-O	Vol. % In Blend	F-1 Clear	Vol. % A-O	Vol. % In Blend	F-1 Clear	Vol. % A-O	Vol. % In Blend	F-1 Clear	Vol. % A-O	F-1 Clear	Vol. % A-O	By Octane Blending Correlation	By Linear Blending of Performance Numbers
	P-N Portion of Reformate			A-O Portion of Reformate															
1	58.5	25.0	0.0	41.5	*140.9	100.0	....	.....	.....	.....	.....	.....	.....	.....	.....	73.1	41.5	.....	.....
2	54.5	34.6	0.0	45.5	*136.4	100.0	....	.....	.....	.....	.....	.....	.....	.....	.....	80.9	45.5	.....	.....
3	46.9	37.9	0.0	53.1	*126.0	100.0	....	.....	.....	.....	.....	.....	.....	.....	.....	84.7	53.1	.....	.....
4	42.6	37.7	0.0	57.4	*129.3	100.0	....	.....	.....	.....	.....	.....	.....	.....	.....	90.3	57.4	.....	.....
	Light Reformate Cut			Aromatic Extract			Reformate												
5	14.9	70.7	6.4	55.9	103.8	91.3	29.2	74.7	35.9	.....	.....	.....	.....	.....	.....	95.5	62.5	94.4	95.7
6	15.2	70.7	6.4	57.2	103.8	91.3	27.6	84.8	43.3	.....	.....	.....	.....	.....	.....	97.6	65.2	96.4	97.0
7	15.4	70.7	6.4	58.0	103.8	91.3	26.6	91.5	49.2	.....	.....	.....	.....	.....	.....	98.7	69.1	98.1	98.2
8	26.1	69.6	3.1	73.9	†106.0	97.8	....	.....	.....	.....	.....	.....	.....	.....	.....	99.7	73.1	101.5	100.9
9	16.8	70.4	5.5	83.2	†105.6	96.2	....	.....	.....	.....	.....	.....	.....	.....	.....	100.6	81.0	102.8	101.4
10	16.2	70.0	4.3	54.2	103.8	91.3	29.6	85.2	33.5	.....	.....	.....	.....	.....	.....	96.7	60.1	96.1	96.5
11	15.0	70.7	6.4	56.3	103.8	91.3	28.7	82.9	38.1	.....	.....	.....	.....	.....	.....	97.3	63.3	96.0	96.6
12	15.1	70.7	6.4	56.7	103.8	91.3	28.2	72.7	32.4	.....	.....	.....	.....	.....	.....	95.2	61.6	94.3	95.5
13	15.4	70.7	6.4	57.9	103.8	91.3	26.7	66.2	24.7	.....	.....	.....	.....	.....	.....	94.2	60.4	93.6	95.3
14	16.2	70.7	6.4	61.0	103.8	91.3	22.8	94.1	50.1	.....	.....	.....	.....	.....	.....	98.9	68.2	98.7	99.0
15	14.9	70.7	6.4	55.9	103.8	91.3	29.2	74.7	35.7	.....	.....	.....	.....	.....	.....	95.4	62.4	94.4	95.6
16	15.2	70.7	6.4	57.2	103.8	91.3	27.6	84.8	43.9	.....	.....	.....	.....	.....	.....	97.2	65.3	96.6	97.4
	Aromatic Extract			N-Heptane			ISO-Octane												
17	50.0	103.8	91.3	20.0	0.0	0.0	30.0	100.0	0.0	.....	.....	.....	.....	.....	.....	90.6	45.6	88.0	97.3
18	90.0	103.8	91.3	10.0	0.0	0.0	....	.....	.....	.....	.....	.....	.....	.....	.....	100.2	82.2	99.7	101.0
19	50.0	103.8	91.3	50.0	0.0	0.0	....	.....	.....	.....	.....	.....	.....	.....	.....	67.0	45.6	96.6	86.8
20	10.0	103.8	91.3	90.0	0.0	0.0	....	.....	.....	.....	.....	.....	.....	.....	.....	13.8	9.1	14.5	37.9
	Thermally Reformed Reformate			ISO- Pentane			N-Pentane			Reformate			Tail Gas						
21	44.5	85.3	49.6	4.8	92.3	0.0	2.1	61.7	0.0	47.8	93.4	74.7	0.8	79.0	0.0	90.4	57.8	88.6	89.6
22	43.3	92.1	56.7	3.4	92.3	0.0	2.1	61.7	0.0	49.7	93.4	74.7	1.5	79.0	0.0	92.4	61.7	91.5	92.3
23	38.4	96.6	65.5	4.3	92.3	0.0	2.5	61.7	0.0	52.4	93.4	74.7	2.4	79.0	0.0	94.2	64.3	93.0	94.0
24	41.9	99.3	86.5	3.8	92.3	0.0	2.0	61.7	0.0	52.2	84.3	47.3	0.1	79.0	0.0	90.2	60.9	91.0	95.8
25	40.0	102.0	91.6	4.1	92.3	0.0	2.2	61.7	0.0	53.4	84.3	47.3	0.3	79.0	0.0	91.4	61.9	92.6	97.1
	Reformate			Str. Run Gasoline															
26	30.0	94.2	64.0	70.0	68.7	5.8	....	.....	.....	.....	.....	.....	.....	.....	.....	75.3	23.3	76.9	79.6
27	70.0	94.2	64.0	30.0	68.7	5.8	....	.....	.....	.....	.....	.....	.....	.....	.....	86.7	46.5	87.9	89.2
	Aromatic Extract			Str. Run Gasoline															
28	30.0	103.2	93.2	70.0	68.7	5.8	....	.....	.....	.....	.....	.....	.....	.....	.....	80.9	32.0	82.2	86.2
29	70.0	103.2	93.2	30.0	68.7	5.8	....	.....	.....	.....	.....	.....	.....	.....	.....	96.8	67.0	96.4	97.8
	Aromatic Extract			Cat Cracked Gasoline															
30	36.0	103.2	93.2	70.0	91.1	63.1	....	.....	.....	.....	.....	.....	.....	.....	.....	95.6	72.1	95.6	95.7
31	70.0	103.2	93.2	30.0	91.1	63.1	....	.....	.....	.....	.....	.....	.....	.....	.....	100.0	84.2	100.1	100.4
	Reformate			Cat Cracked Gasoline			Str. Run Gasoline												
32	35.0	94.2	64.0	35.0	91.1	63.1	30.0	68.7	5.8	.....	.....	.....	.....	.....	.....	86.7	46.2	86.3	87.8
33	30.0	94.2	64.0	50.0	91.1	63.1	20.0	68.7	5.8	.....	.....	.....	.....	.....	.....	88.6	51.9	88.1	89.2
34	20.0	94.2	64.0	35.0	91.1	63.1	45.0	68.7	5.8	.....	.....	.....	.....	.....	.....	82.9	37.5	82.4	84.5
	Str. Run Gasoline			Cat Cracked Gasoline			Aromatic Extract												
35	60.0	68.7	5.8	40.0	91.1	63.1	....	.....	.....	.....	.....	.....	.....	.....	.....	78.5	28.7	78.4	80.3
36	50.0	68.7	5.8	35.0	91.1	63.1	15.0	103.2	93.2	.....	.....	.....	.....	.....	.....	83.6	39.0	83.5	86.2

* Calculated by linear volumetric blending.
† Calculated using the octane blending correlation and linear volumetric blending.

Figure Octanes of Blends This Way . . .

the following equation representing linear volumetric blending:

$$(A)(Y) + (P)(X) = (100)(F) \qquad (1)$$

Where:

A = volume percent aromatic-olefin (A-O) fraction of the blend
P = volume percent paraffin-naphthene (P-N) fraction
Y = blending octane of the A-O fraction
X = blending octane of the P-N fraction
F = clear Research octane number of the blend

Table 1 summarizes a total of 36 blends which were used to develop and test an octane blending correlation. These blends represent a variety of refinery streams and include components varying in Research clear octane number from 0 to over 100. In each blend at least one of the components is high in aromatic content. The composition of all components were determined by mass spectrometer analysis.

Research octane numbers above 100 were reported as iso-octane plus cc of TEL per gallon. The Deters correlation was used to convert these values to octane number, although the Deters extension shows a maximum octane number of 106.5 for values of iso-octane plus 1.3 cc TEL and higher.

Analyses of specific blends indicated the following trends:

- The blending values of aromatic and olefin components decrease as their concentration increases.
- The blending values of aromatic and olefin components decrease as the octane number of the paraffin-naphthene fraction increases.

These considerations ultimately led to the development of the following correlating factor:

$$R = \frac{Y - 106.5}{106.5 - X} \qquad (2)$$

The octane ratings of the paraffin-naphthene portions of blends No. 1 through 4 were used to get the first estimation of "R" as a function of aromatic content. This relation is shown in Figure 1.

This relation was applied then to the other blend data. Thus, it was possible to estimate the blending octane of each of the paraffin-naphthene portions of the various blend components as follows:

The value of X for a blend was obtained by combining the estimated blending octane numbers of the paraffin-naphthene portions of components using a linear volumetric blending technique. The value of Y for a blend was calculated from X and the experimental octane of the blend using the linear volumetric blending technique. Then calculated values of "R" were obtained for all of the blends. This defined a slightly different curve than that shown in Figure 1.

The construction of an adjusted curve allowed new values of "R" to be calculated and plotted. This process was continued until the values of "R" remained unchanged. The resultant correlation of "R" as a function of aromatics content is shown in Figure 2.

The data shown in Figure 2 define a single line correlation from 40 to 100 volume percent aromatics plus olefins. Below 40 percent there is a scattering of data because of the increasing sensitivity of "R" to the accuracy of the experimental data. As an example, at 20 volume percent aromatics plus olefins a difference in

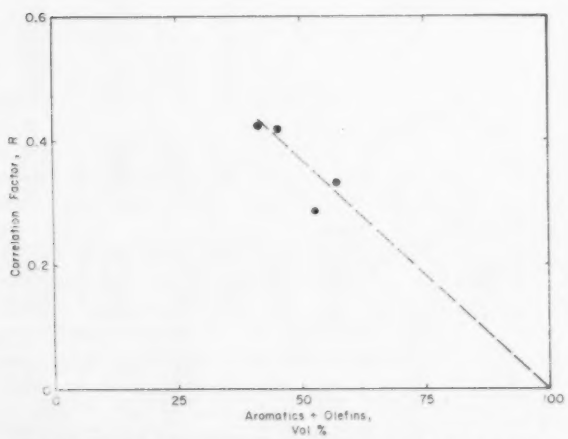

FIGURE 1—Analyses of specific blends ultimately led to the development of a correlation factor.

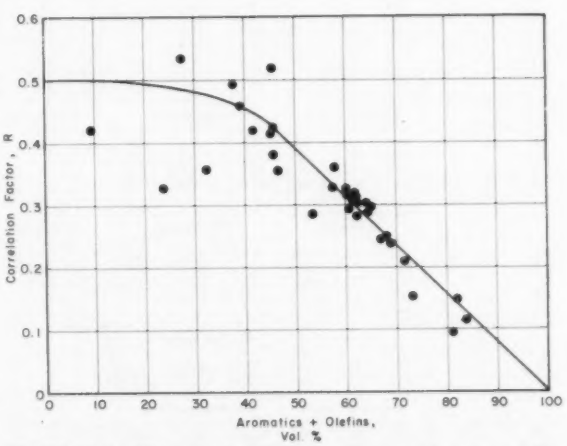

FIGURE 2—The calculation process was continued until the values of "R" remained unchanged.

TABLE 2—Example Problem

Component	Volume Percent In Blend	Clear F-1 O.N.	Volume Percent A-O	Volume Percent P-N	Blending O.N. for P-N
Lt. St. Run Gaso.....	40.0	70.4	5.5	94.5	67.0
Reformate Fraction...	50.0	92.8	72.5	27.5	—9.2
n-Pentane.....	10.0	61.7	0	100.0	61.7
Total.....	100.0	F	38.4	61.6	X

TABLE 3—Calculation Reliability

Percent of Time a Calculated Value Will Fall Within The Brackets	Deviation from the Experimental Value (Octane Numbers)
99%	±3.0
95%	±2.3
90%	±1.9
70%	±1.2

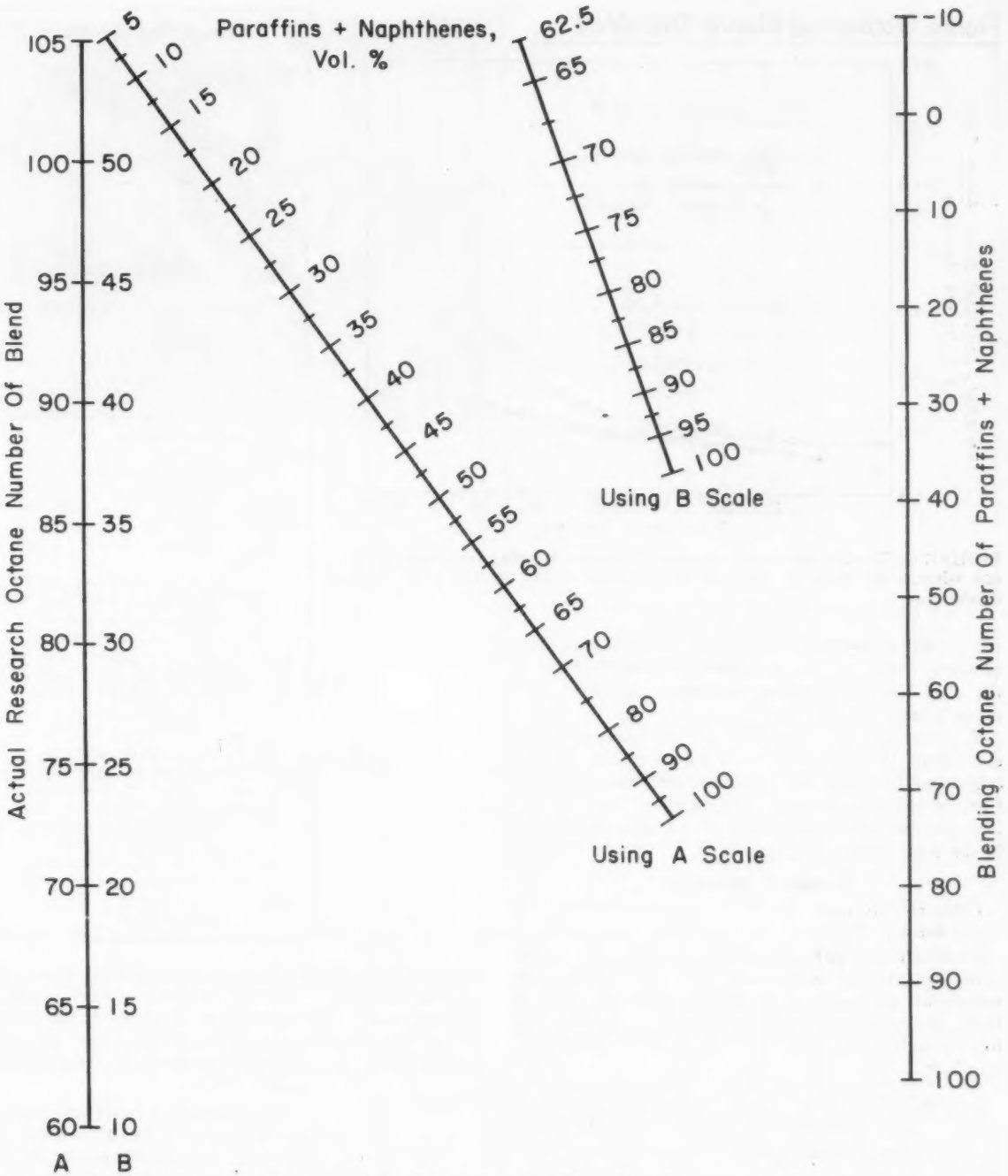

FIGURE 3—This nomograph accounts for the influence of aromatics and olefins upon the final octane of a blend.

octane measurement of 1.1 numbers can change "R" from 0.4 to 0.5.

Combining equations (1) and (2) with a simple material balance gives the following equation:

$$X = \frac{(100)(F) - (106.5)(100 - P)(1 + R)}{100 - (100 - P)(1 + R)} \quad (3)$$

However, since "R" has been empirically determined for all values of aromatic content (or 100 — P), X for a component can be expressed as a function of the actual octane rating and paraffin-naphthene content.

A quick solution of blending problems can be achieved from the nomograph in Figure 3 which is a representation of Equation (3). Its application involves the following steps:

1. Determine the clear F-1 octane number and the paraffin-naphthene concentration for each component of the blend.

2. Determine the F-1 blending number for the paraffin-naphthene fratcion of each component using the nomograph in Figure 3.

3. Combine the F-1 blending numbers of the individ-

Figure Octanes of Blends This Way . . .

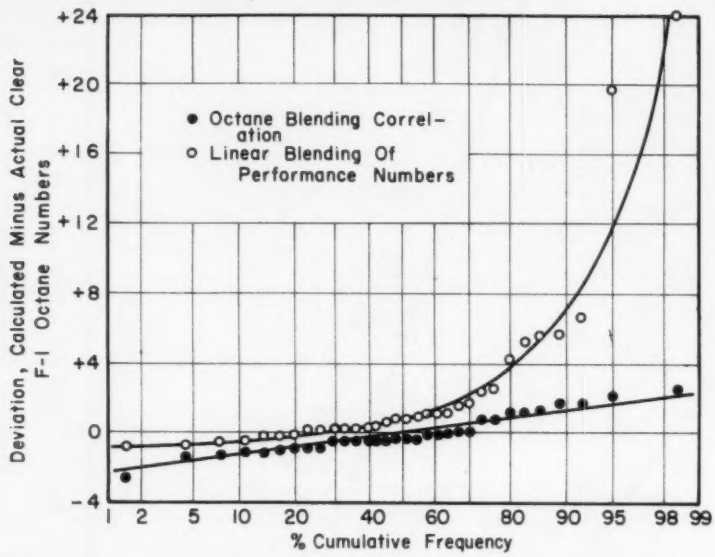

FIGURE 4—The distribution of error for the octane blending correlation is normal whereas the linear blending by performance number method gives a skew distribution.

ual paraffin-naphthene fractions to determine the blending octane of the paraffin-naphthene fraction of the total blend. The linear volumetric blending technique is used for this step.

4. Determine the clear F-1 octane number of the blend from the nomograph in Figure 3 by entering the calculated blending octane of the paraffin-naphthene fraction of the total blend (from Step 3), and the volume percent concentration of the paraffin-naphthenes in the total blend.

EXAMPLE PROBLEM

Calculate the clear Research octane number of the blend given in Table 2.

Determine for each stream the octane number of the paraffin-naphthene portion using the nomograph. The values obtained are listed in the last column of Table 2. Next, determine the blending octane number of the total paraffin-naphthene fraction by linear volumetric blending.

$$X = \frac{(40.0)(94.5)(67.0) + (50.0)(27.5)(-9.2) + (10.0)(100.0)(61.7)}{(40.0)(94.5) + (50.0)(27.5) + (10.0)(100.0)}$$

$= 49.1$ clear Research O.N.

The volumetric concentration of the paraffin-naphthene fraction is:

$(40.0)(94.5) + (50.0)(27.5) + (10.0)(100.0) = 61.6$ vol %

Using a 49.1 blending octane and 61.6 volume percent concentration for the paraffin-naphthene fraction, read from the nomograph: *a final blend of 81.2 clear Research octane number.*

HOW GOOD IS THE METHOD

The deviation of octane ratings (calculated minus experimental values) versus the frequency of determination are shown in Figure 4 for the octane blending correlation developed here and for the technique of lineally blending performance numbers. The distribution of error for the octane blending correlation is normal whereas the linear blending by performance number method gives a skew distribution of error. By the latter method there is a reasonable probability that the calculated value may be much greater than the experimental value.

The reliability of the octane blending correlation is shown in Table 3. Although the correlation was developed for clear Research octane numbers, similar correlations should be possible for leaded Research octane numbers and clear and leaded Motor octane ratings.

In this correlation the Deters extension was used for octanes above 100. This correlation can be applied to the Wiese scale and other extensions if octane ratings are first converted to Deters values before applying the nomograph and then converted back to the particular scale in use.

(Based on a presentation at the Delaware Valley Regional Meeting of the American Chemical Society, February, 1958.)

LITERATURE CITED

[1] Deters, PETROLEUM REFINER, June, 1951, Page 127.

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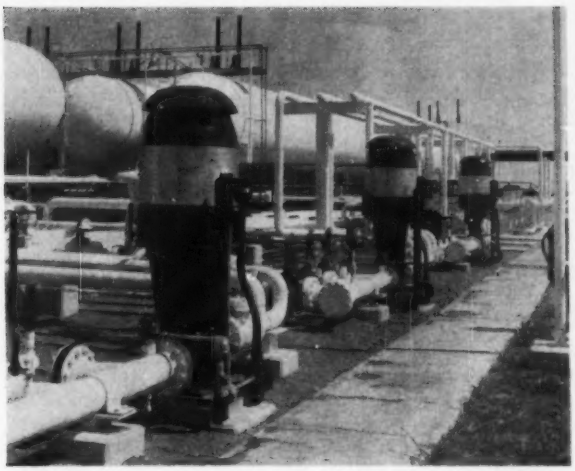
E. R. Westfield is supervisor of economic planning for Tidewater Oil Co., Delaware City, Del. He is in charge of economic evaluations and planning, crude evaluations and related studies. Holder of a B.E. degree in chemical engineering from Vanderbilt University and a M.S. degree in chemical engineering from Massachusetts Institute of Technology, he has been with Tidewater since 1957. From 1947-51, Westfield was a process design engineer for American Oil Co., Texas City, and from 1951-57 was a chemical engineer for Houdry Process Corp., Marcus Hook, Pa.



Operator's Handbook for Gasoline Plants

WHAT'S AHEAD . . .

- **Installation Hints**
  - Factory Assembly
  - Field Installation
  - Pump Alignment
  - NPSH
  - Suction Piping
  - Discharge Piping
  - Piping Connections
  - Mechanical Seals
  - Lubrication
- **Operating Hints**
  - Priming
  - Routine Checks
  - Pumping at Reduced Capacity
  - Pumping at High Temperatures
  - Speed Changes
  - Specific Gravity Effects
  - Viscosity Effects
  - Vibration
  - Steam Turbines

PART 6 – Rotary Pumps: One of a series that simplifies operations and equipment for the new and experienced operator in a natural gasoline plant

Manufacturing Department
Bay Petroleum Company, A Division of
Tennessee Gas Transmission Co., Houston

ROTARY PUMPS are of two types—centrifugal and gear. Basically the centrifugal pump (the main form of rotary pump) is built around an impeller, which is a series of radial vanes spinning in a circular casing. Fluid enters at the eye (axis of rotation) and discharges through the vanes at a higher pressure.

This pump may have closed or open impellers. Open-type impellers have one disc with the radial vanes on one side of the disc. This type of impeller is used almost entirely in single-stage, low-head pumps. The open impeller type is very critical in case clearance since the case is the seal between suction and discharge pressures.

The closed impeller is dependent upon wear rings with a close clearance at the eye of the impeller for seal between the suction and discharge pressures. It is used for multistage and high head pumps.

Multistage pumps have two or more impellers. This type is used for high to very high differential pressures. Operation is the same as the single stage except for the handling of the fluid. Instead of going through one impeller and out of the pump, each impeller discharge is directed into the suction of the next. Each one multiplies the centrifugal force exerted against the pumped fluid until it is discharged from the pump.

The deep well centrifugal pump has been reduced in size so that multistage units will fit into well casings as small as 4 inches in diameter. The pump assembly can then be lowered to the liquid level. The driver is kept at the surface with a long drive shaft extending

down to the pump. Most plant well water supplies are produced from this type of installation.

The gear type rotary pumps have two gear-like rotating elements. These gears rotate and are confined in a housing with close clearances. The fluid enters the pump, is trapped in the gear teeth, and rotates to the opposite side of the pump. Meshing of the gears and close clearance around the housing seal the suction from the discharge. This type pump is used in small volume pumps for water, oils, and engine lubrication service. Nearly all internal combustion engines have this type for oil pump service.

The centrifugal pump, on the other hand, is the commonest type in gasoline plants. The ensuing installation and operating hints are standard practice for centrifugal pumps. These hints combine theory and experience so the operator will be familiar with the problems of pump design, installation and operation.

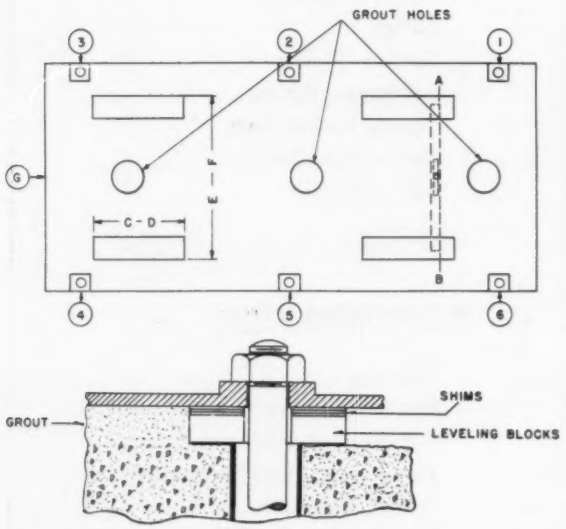


FIGURE 20—Leveling the base plate is first step in installing a pump.

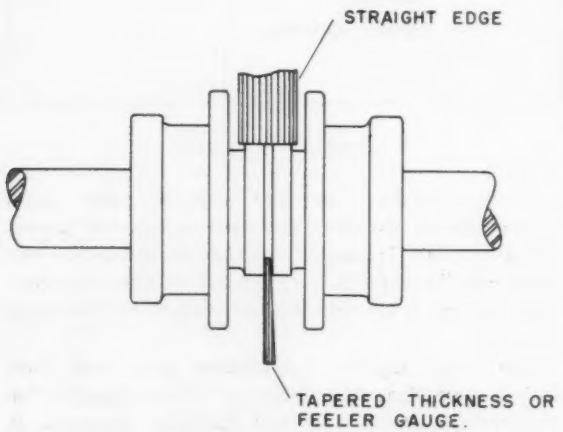


FIGURE 21—Standard flexible coupling for aligning horizontal pump and driver.

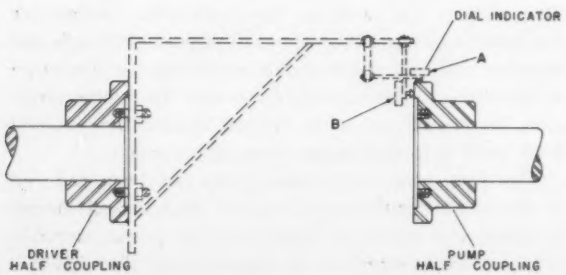


FIGURE 22—Floating shaft coupling for alignment.

Factory Assembly. When a unit consisting of a pump, baseplate, coupling and driver is assembled at the factory, the baseplate is supported without strains on a level surface, the pump and driver mounted on the base and the coupling halves aligned. This alignment will be disturbed during shipment and in the field, making it necessary to reproduce this alignment after the unit has been set on the foundation.

Field Installation. Successful operation of a pump depends largely upon careful installation. During field work, every precaution must be used to prevent foreign material from entering the pump and causing unnecessary damage. Do not remove protectors from pipe openings until the unit is ready to start. No welding should be done on pipes after they have been connected to the pump; if welding is necessary, disconnect pipe at the pump, then weld.

The first step is installation of the base plate. Use flat iron or steel blocks not less than 1 inch thick with shims. Locate one block on each side of each foundation bolt and one block at point G as shown by Figure 20. Set the unit on the leveling blocks and if the driver is coupled to the pump, remove the bolts from the coupling. With a spirit level on the pads:

1. Level one end of the baseplate in direction A-B, using the blocks and shims at foundation bolts 1 and 6. When end is level, firmly tighten nuts on foundation bolts 1 and 6.
2. Level base in direction C-D using block and shims at G. Remove or add shims at blocks 2-5 and 3-4 if necessary.
3. Level baseplate in direction E-F and firmly tighten nuts on foundation bolts 2 and 5, then 3 and 4.
4. After nuts are firmly tightened on all foundation bolts, check levels A-B, C-D and E-F and make adjustments if necessary.
5. Pour grout and allow 48 hours for grout to "set" after which check nuts on foundation bolts for tightness.

Adjust the position of the driver on the baseplate so that:

1. The clearance between the coupling faces is the same as shown on the certified drawing.
2. Check the alignment with a straight edge across the coupling flanges. With the straight edge across the top, the driver flanges may be from .04 inches to .07 inches low. With the straight edge across the sides; both halves should be in alignment.
3. Scribe the location of hold-down bolts, remove driver from base, drill and tap holes for holding bolts.

Aligning Horizontal Pump and Driver. This must be accurate. A flexible coupling is not a universal joint and must be aligned with the same care and with the same accuracy as a rigid coupling. Misalignment will cause noise, shaft vibration, hot bearings, rapid wear

of bearings, bushings, rings and packing and may cause the rotating element to seize.

Before proceeding to align the pump and driver, remove the protective coating and thoroughly clean the coupling and shaft. If the driver is mounted in the field, the driver feet and the pads on the baseplate should be thoroughly cleaned. Remove the coupling bolts. Adjust the hold down bolts on the driver—finger tight. Check the hold down bolts on the pump for tightness.

The pump has been leveled, aligned and firmly bolted to the base at the factory and in the field it is seldom necessary to do other than align the driver with the pump. The driver pads on the baseplate are machined slightly low which permits all adjustments during alignment to be made by shims under the driver feet.

When aligning an electric motor on a centerline mounted steam turbine, no special allowance is made for the effects of temperature. Whenever possible, a foot mounted steam turbine should be brought up to its operating temperature and aligned while hot. If it must be aligned cold, the turbine half coupling should be set low by the amount specified by the turbine builder for the operating steam conditions. Cold alignment should be considered as preliminary only, and it should be checked after the turbine is brought up to operating temperature, and adjustments made if necessary. A steam turbine driven pumping unit should not be put in service until the alignment has been checked with the turbine at full operating temperature.

When field alignment is completed, the faces of the coupling hubs should be parallel within manufacturer's limits and coupling hubs should also be within limits.

To align horizontal pump and driver:

A. With standard flexible coupling (Figure 21).

1. Separate the coupling hubs. The proper distance is shown on the certified foundation plan and is also stamped on the coupling hub. Check this distance with tapered thickness gage or feelers.

2. Line up shafts with a straight edge across the aligning faces of the hubs.

B. With floating shaft coupling (Figure 22).

1. Remove floating shaft and clamp bracket for dial indicator to driver half coupling.

2. To check radial alignment, set dial indicator at A, rotate both shafts together and take readings at 90 degree points on the circle.

3. To check axial alignment, set dial indicator at B, rotate both shafts together and take readings at 90 degree points on the circle.

4. To check radial and axial alignment, clamp bracket to pump half coupling and repeat operations 2 and 3.

A final check of the alignment should be made after the suction and discharge pipes are bolted to the pump. Any adjustment in alignment that may be necessary should be made before starting the pump.

Aligning Vertical Pump and Driver. When shipped, the rotor of a vertical pump may not be in its operating position. The shoulder of each impeller skirt will be seated on the top of the bowl wearing ring, and the bottom end of the shaft resting on the adjusting screw, in the lower bearing housing as shown by Figure 25. The rotor will remain in this position until the pump shaft is lifted by the adjusting nut N, Figure 24, or by tightening the coupling bolts (Figure 25). But the position of the adjusting screw (Figure 25) should not be changed and it must not be used for lifting the rotor to its operating position.

The alignment of some vertical pumps is facilitated by an accurately turned centering ring with male fitting on the driver mount and female fitting in the driver flange (Figure 23).

The alignment procedure is:

1. Level pump on foundation with spirit level on machined surface.

2. Pour grout—allow 48 hours for grout to "set," then firmly tighten nuts on foundation bolts.

3. Hollow shaft drivers are positioned by the centering ring. The flange bolts are then firmly tightened as further check of the alignment is unnecessary. Lift the pump shaft according to specifications by means of the adjusting nut N on the driver end of the shaft (Figure 24).

Solid shaft drivers are connected to the pump by means of an adjustable flanged coupling (Figure 25). To align the solid shaft driver:

1. Remove key K and turn pump half coupling down until the face is flush with the end of pump shaft S.
Pump half coupling will then be in Position 1.

2. Set driver on driver mount and turn pump half coupling up until face of pump and driver half flanges are flush. Pump half coupling will then be in Position 2.

3. Lift driver, turn pump half coupling down until keyways match and insert key. Pump half coupling will then be in Position 3. CAUTION—Do not turn coupling up to match keyway and do not turn down more than one complete turn.

4. Lower driver on driver mount and check the distance D with pump half coupling in Position 3. Distance D should

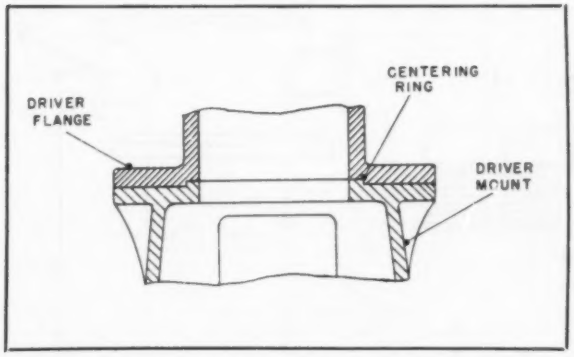


FIGURE 23—A centering ring on the driver mount helps align vertical pumps to driver.

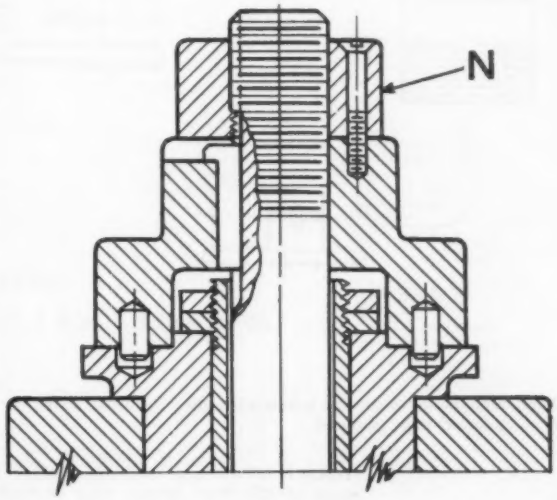


FIGURE 24—Pump shaft (right) is lifted by adjusting nut (N) on driver end of hollow shaft.

not be more or less than specifications. Also, check the vertical alignment with a straight edge across the coupling flanges. The driver may be shifted slightly if necessary. Coupling faces should be parallel within limits and flanges in line within limits.

5. When alignment is completed, tighten holding down bolts on driver flange and then firmly tighten the coupling bolts. Coupling will then be in its final Position 4. When the coupling bolts are tight, the rotating element of the pump will be lifted to its operating position.

Net Positive Suction Head. Any liquid, regardless of its temperature, can neither be sucked nor pulled, but must be pushed into the impeller of a centrifugal pump. The equivalent head in feet of liquid necessary to push the required number of gallons per minute of liquid into the impeller is expressed as the *Net Positive Suction Head*. For convenience, this term has been shortened to NPSH and is always measured over and above the vapor pressure of the liquid at the pumping temperature.

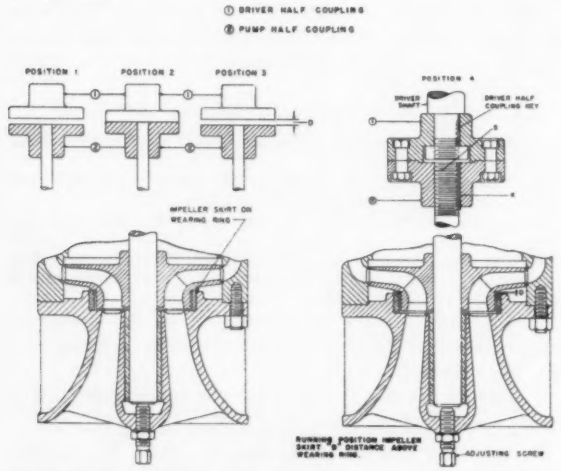


FIGURE 25—Solid shaft drivers are mounted to the pump by an adjustable flange coupling.

Two types of NPSH are to be considered. One is determined by the plant design engineer and is based on the condition of the liquid, the design of the suction line and the location of the pump. This is the available NPSH of the system. The other, based on test data, is the required NPSH of the pump and is specified by the pump manufacturer as the required NPSH.

Each centrifugal pump has its individual required NPSH which is shown on the performance curve of the pump submitted by the manufacturer. To prevent vaporization in the entrance to the impeller, the available NPSH must be equal to or greater than the required NPSH.

A pump may be installed below or above the level of the liquid to be pumped as shown diagrammatically by Figure 26. For a pump below the liquid level, Case 1, the available $\text{NPSH} = Z + \frac{(P - Pv)\ 2.31}{\text{Sp. Gr.}} - (Hf + He)$

For a pump above the liquid level, Case 2, the available $\text{NPSH} = \frac{(P - Pv)\ 2.31}{\text{Sp. Gr.}} - (Z + Hf + He)$

where

Z = Vertical distance in feet from the Centerline of the pump to the level of the liquid.
P = Pressure on the surface of the liquid in psi absolute.
Pv = Vapor pressure of the liquid at the pumping temperature in psi absolute.
Sp. Gr. = Specific Gravity of liquid at pumping temperature.
Hf = Friction loss in feet head through suction pipe and fittings.
He = Loss in feet head at entrance to suction pipe.

When the available NPSH is limited, a vertical pump of the type by Figure 27 may be used to advantage. The available NPSH for a pump of this type need only be sufficient (1 foot or less) to maintain the required rate of flow in gpm at the suction nozzle S.

Suction Piping should be short, direct and never be smaller in diameter than the suction opening of the pump. When long lines cannot be avoided, the diameter of the piping should be at least one, or preferably two

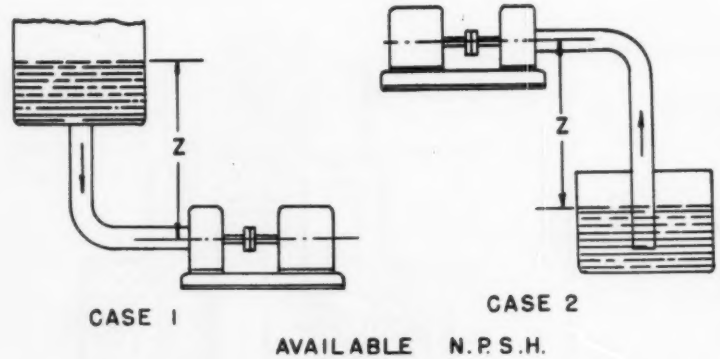


FIGURE 26—Schemes for a pump installed below or above the level of liquid to be pumped.

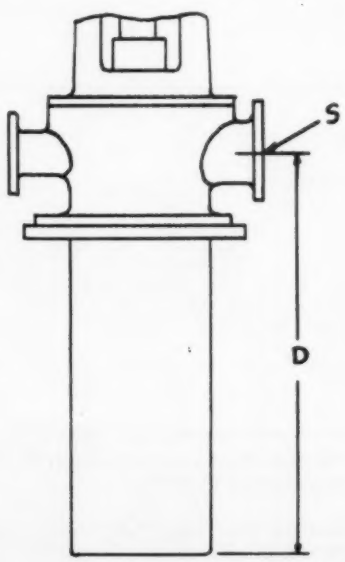
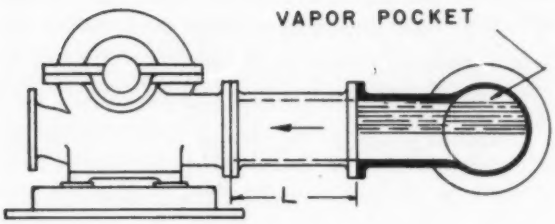


FIGURE 27—When available NPSH is limited, a vertical pump of this type (right) may be used.

Do's and Dont's for Suction Lines



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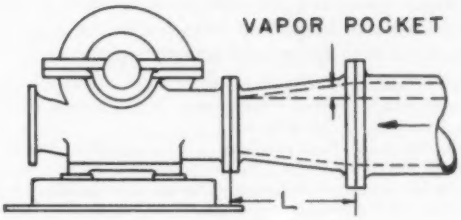

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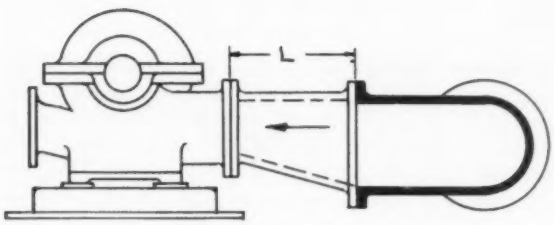

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Figure 28

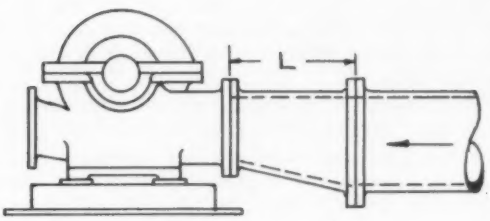

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Figure 29

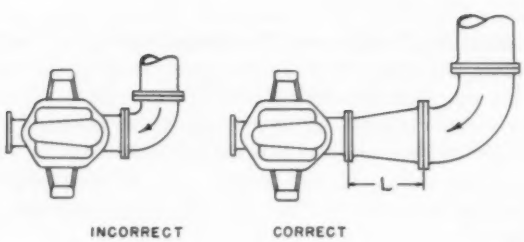

Figure 30

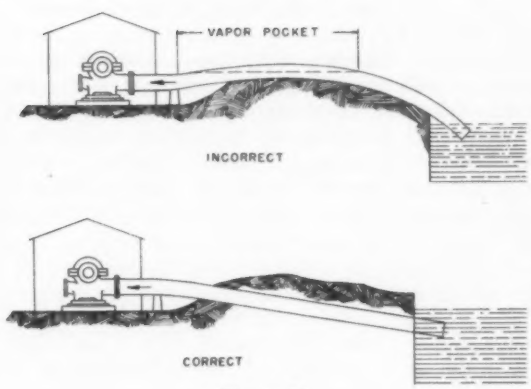

Figure 31

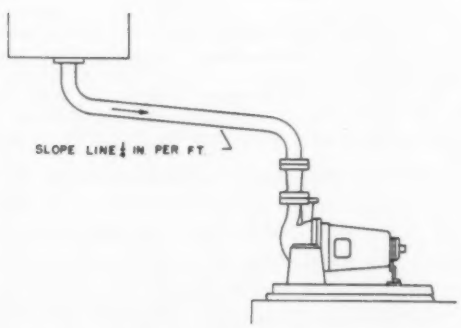

Figure 32

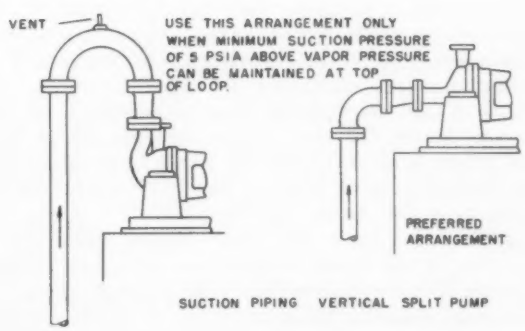
VENT
USE THIS ARRANGEMENT ONLY WHEN MINIMUM SUCTION PRESSURE OF 5 PSIA ABOVE VAPOR PRESSURE CAN BE MAINTAINED AT TOP OF LOOP.
PREFERRED ARRANGEMENT
SUCTION PIPING VERTICAL SPLIT PUMP

Figure 33

sizes larger than the suction opening of the pump. Suction lines should be free from pockets or high spots in which gas or vapors may be entrapped.

A well designed suction line will:

1. Slope gradually from the pump to the source of liquid supply. See Figures 31 and 32.
2. Provide long radius elbows or long radius bends. See Figures 30 and 32.
3. Provide eccentric increasers for change in size of horizontal lines. See Figures 28 and 30. The length *L* of reducers or increasers should not be less than twice the diameter of the larger pipe.
4. Prevent strains on the pump nozzle by making adequate provisions for the expansion of hot lines.
5. Provide adequate supports and bracing for the line.

When a strainer or foot valve is used on the inlet end of a suction line, the clear and free area through either should be three to four times the area of the suction pipe.

Unnecessarily long shutdowns and unnecessary expense may be avoided by careful observation of the behavior of a pump. When trouble occurs, the behavior of the pump usually indicates whether the cause is mechanical or hydraulic. Mechanically, a centrifugal pump is a very simple machine and subject to very few mechanical troubles. In the majority of cases, hydraulic troubles originate in the suction system. The condition that is causing trouble may be located and the remedy may be perfectly clear. However, the reason why a certain condition will cause trouble may not be clear and a brief explanation of what takes place in a suction system may be helpful.

Figure 34 illustrates four typical suction systems, together with the pressures at different points inside the suction line. To obtain the rated capacity from a centrifugal pump, a definite pressure in psi or the equivalent head in feet of liquid must be maintained in the suction eye of impeller E. Any condition that will cause the pressure in E to drop below that required for the rated capacity will cause trouble.

For example, in systems 1 and 3, the pressures of the suction line are below the pressure of the atmosphere and a defective joint would allow air to leak into the line and this would cause trouble. In systems 2 and 4, the pressures in the line are above atmospheric and liquid would leak out through a defective joint.

Air or gas cause trouble in a suction system because both are highly elastic and will expand and increase in volume with any decrease in pressure. When air or gas expands in a suction line, liquid is displaced and the capacity of the pump is reduced accordingly. The exact volume of air or gas released and the volume of liquid displaced cannot be calculated accurately because of the multiplicity of flow conditions in the suction system. However, experience has shown that the effects of air or gas liberated in a short suction line are less pronounced than in a long line. For this reason, short lines are always recommended.

Either air leaks in the suction line, or air or gas in solution in the liquid pumped, would cause serious trouble if not complete failure of a pump located as shown in system 1. Theoretically, air or gas in expanding from 14.7 to 6.1 psia would increase in volume $\frac{14.7}{6.1} = 2.4$ times and displace 2.4 volumes of liquid. If the liquid pumped contained 2 percent of air or gas in solution at 14.7 psia and the suction line was air tight, the air or gas in solution would expand and increase $\frac{14.7}{6.1} \times 2 = 4.9$ percent in volume at E. While the actual expanded volume at E would in either case be less than the theoretical, it would be sufficient to cause serious trouble.

In suction system 3, the pressure in the suction line is higher at E than at L, but lower than atmospheric pressure at all points in the line; consequently, air leaking through a defective joint would rise and be released in the vacuous space above L and lower the vacuum. Air leaking through defective packing or because of defective sealing of the stuffing box or boxes on the suction side of the pump would have the same effect.

Discharge Piping. Because the bhp expended in unnecessary friction is wasted energy, discharge lines should be of ample size and incorporate a minimum of fittings. Determining the diameter of a discharge line depends upon the length of the line and the pressures involved. For short lines and high pressures, velocities up to 15 feet per second may be permissable while for long lines and low pressures, velocities from 3 to 5 feet per second may be the economic maximum. The discharge line should be provided with adequate supports to prevent strains on the pump nozzle.

A discharge cushion chamber may be used if discharge pulsations and line vibration are troublesome. There are three types available—bladder, tube and baffle, and gas blanket.

Connecting Suction and Discharge Piping. When installing suction and discharge piping, every precaution must be taken to prevent pipe scale, welding slag or other foreign material in the pipe from entering the pump. Neglect of these precautions will result in unnecessary damage to the interior parts of the pump.

When installing the suction line, it's recommended that:

1. The inside of the pipe be turbined to provide a clean surface.
2. As the line is erected, a swab fitting the entire cross section of the pipe be pulled through each section to assure the removal of scale or other foreign material.
3. A temporary screen made from #10 mesh steel wire screen backed with ¼-inch mesh hardware cloth be installed at or near the suction nozzle of the pump. The purpose of this screen is to catch all welding beads, scale or other foreign material from any source. This screen should remain in the line for at least 24 hours after starting the pump.
4. A pressure gage be installed on each side of the temporary suction screen to measure the pressure drop across the screen.
5. No welding should be done on pipe lines while they are bolted to the pump. If welding is necessary, disconnect the line at the pump to prevent welding shot from entering the pump.

The face of pipe flanges must be parallel and flush with the flanges of the nozzles on the pump. Piping must not be pulled into position with the flange bolts.

Before bolting the piping to the pump, inspect and check the entire line to be sure:

1. The lines slope in the right direction.
2. There are no high spots or pockets in which air, gas or vapors can collect.
3. All pipe supports, valves and fittings are in their proper

locations and that all eccentric reducers or increasers are properly installed.

Mechanical Shaft Seals. The sealing surfaces of mechanical seals are highly polished and optically flat. The utmost care must be used to keep these surfaces perfectly clean and free from dust, dirt or gritty substances that would scratch or mar the polished surfaces. When installing mechanical shaft seals, the manufacturer's instructions must be followed to the letter.

Bearing Lubrication. Before shipment, the bearings are thoroughly cleaned and sprayed with rust inhibitor. When the installation is completed, the bearings should be inspected to prevent damage from condensation, grit or other foreign material which may have entered the bearings or lubricating system during shipment, storage or in the field. Before filling with lubricating oil, all bearings and oil reservoirs should be thoroughly washed with kerosine. When bearings are pressure lubricated, the entire lubricating system including the oil reservoir, pump, cooler and piping should be thoroughly washed with kerosine. Then after drying, the system is filled.

When filling a pressure lubricating system the first time, or refilling after draining oil, it is important that the system be filled completely.

Lubricating Oil. The ideal lubricant is a refined straight neutral mineral oil, preferably of the turbine type. It should not contain free acid, chlorine, sulfur, or not more than a trace of free alkali. It must be a clean, high quality oil, free from grit. The use of poor oil may result in corrosion, sludge or loss of oil through excessive evaporation.

Correct viscosity is important. If the viscosity is too low, the lubricating film may be dangerously thin—if too high, the friction may be needlessly high. The viscosities recommended by one company are:

For ring oiled ball and sleeve bearings—SAE-20.

For pressure lubricated thrust and sleeve bearings with oil cooler:

Oil Temperature °F	Viscosity
Under 110	SAE-20
110-140	SAE-30
140-160	SAE-40

The maximum temperature of the oil leaving the bearings should not exceed 160° F. Follow the manufacturer's instructions for lubricating the driver and flexible coupling.

Priming. Before starting a centrifugal pump, the casing and suction piping must be completely filled with liquid. The rotating parts within the pump depend upon this liquid for lubrication and they may seize if the pump is operated dry. The only exception to this rule are pumps specially designed to start dry.

When the pump is located below the level of the liquid to be pumped, it will prime itself when the vent or vents on the top of the pump case are opened to release entrapped air or vapor. Pumps with vertical suction and discharge nozzles are self-venting.

When the pump is located above the level of the liquid to be pumped, an ejector or other means must be provided to expel the air or vapors from the pump casing.

Routine Check. When operators are on constant duty, an hourly check can prevent costly shut downs. Any change in a smooth running pump should be investigated immediately. An hourly routine check should include:

1. Bearing temperatures . . . The bearings will operate at a constant temperature which will be influenced somewhat by the temperature of the surrounding atmosphere. If there is any indication of overheating, check the oil level and the cooling system to see if it is functioning properly. If the oil temperature exceeds 160° F, the pump should be shut down.

2. Packing . . . See if leakage is sufficient for lubricating the packing but not excessive. If there is no leakage or the box overheats, the packing is too tight. Do not back off gland nuts while pump is running, as this will allow the entire set of rings to move away from the bottom of the box without relieving the pressure of the packing on the Shaft Sleeve. The best procedure is to shut the pump down, allow the packing to cool and then restart the pump. It may be necessary to repeat this several times before the proper amount of liquid comes through to provide the lubrication necessary to prevent heating. If leakage is excessive, do not tighten the gland nuts more than one flat at a time. Tightening the gland nuts usually compresses only the two or three outside packing rings and excessive tightening of these rings will interrupt the leakage and cause the rings to burn and score the shaft sleeve. Adjusting the gland pressure slowly, one flat at a time, permits the increased pressure to be distributed throughout the entire set of rings without danger of overheating the packing.

3. Check the cooling water system to make sure the proper amount of cooling water is circulating through the bearing and stuffing box jackets as well as the pedestals.

4. Check suction and discharge pressure gages to see if they correspond to the operating conditions.

When pumping volatile fluids, if at any time the discharge or suction pressure suddenly drops to 0, shut the unit down immediately since the pump has lost suction and the liquid inside the pump is vaporizing. When the pump stops rotating, open the vent valves and, as soon as the vapor has been cleared, prime and start the pump. If normal discharge pressure is established immediately, the vapors have been cleared and the pump is again in normal operation. If the discharge gauge does not show an immediate increase in pressure with increase in speed, shut the unit down at once. The cause for the suction failure, or the cause for the continued vaporization must be found and eliminated even if it means an extended shut down.

Pumping at Reduced Capacity. Should conditions require operation at reduced capacity, some precautions are necessary to avoid damage to the pump. Except in

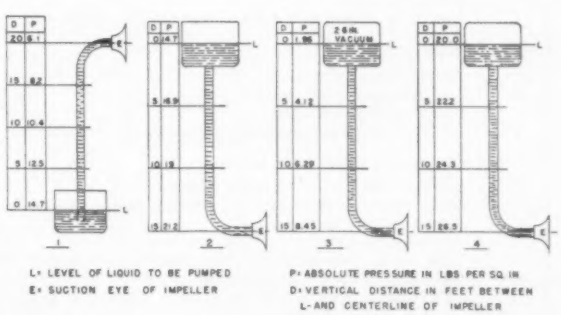
L= LEVEL OF LIQUID TO BE PUMPED
E= SUCTION EYE OF IMPELLER
P= ABSOLUTE PRESSURE IN LBS PER SQ IN
D= VERTICAL DISTANCE IN FEET BETWEEN L AND CENTERLINE OF IMPELLER

FIGURE 34—Four typical suction systems, showing pressure at different points inside the suction line.

special cases, any reduction in the capacity of a pump operating at constant speed should be made by throttling the discharge which will reduce both the capacity and the efficiency of the pump. Because of the drop in efficiency, a greater proportion of the horsepower input will go into heating the liquid in the pump casing. Because this liquid is at suction pressure, the added heat will soon cause the temperature to rise above the boiling point of the liquid at that pressure and the pump will become vapor-bound. A suitable connection must be provided to by-pass sufficient liquid to prevent this overheating and the resultant vaporization.

Reducing the capacity by throttling the suction should not be attempted except in very special cases. Throttling the suction reduces the pressure in the impeller eye which will cause harmful cavitation unless the suction pressure downstream, after throttling, ex-

Check List for Centrifugal Pump Troubles and Causes

1. Failure to deliver liquid:
- a. Wrong direction of rotation
- b. Pump not primed
- c. Suction line not filled with liquid
- d. Air or vapor pocket in suction line
- e. Inlet to suction pipe not sufficiently submerged
- f. Available NPSH not sufficient
  - (1) Height from liquid level to centerline of pump too great (System 1) or
  - (2) Height from centerline of pump to liquid level insufficient (System 3) or
  - (3) Difference between suction pressure and vapor pressure too small (System 4)
- g. Pump not up to rated speed
- h. Total head greater than head for which pump designed.

2. Pump does not deliver rated capacity:
- a. Wrong direction of rotation
- b. Suction line not filled with liquid
- c. Air or vapor pocket in suction line
- d. Air leaks in suction line or stuffing boxes
- e. Inlet to suction pipe not sufficiently submerged
- f. Available NPSH not sufficient
  - (1) Height from liquid level to centerline of pump too great (System 1) or
  - (2) Height from centerline of pump to liquid level insufficient (System 3) or
  - (3) Difference between suction pressure and vapor pressure too small (System 4)
- g. Pump not up to rated speed
- h. Total head greater than head for which pump designed
- j. Foot valve too small
- k. Foot valve clogged with trash
- m. Viscosity of liquid greater than that for which pump designed
- n. Mechanical defects . . .
  - (1) Wearing rings worn
  - (2) Impeller damaged
  - (3) Internal leakage resulting from defective gaskets.

3. Pump does not develop rated discharge pressure:
- a. Gas or vapor in liquid
- b. Pump not up to rated speed
- c. Discharge pressure greater than pressure for which pump designed
- d. Viscosity of liquid greater than that for which pump designed
- e. Wrong rotation
- f. Mechanical defects . . .
  - (1) Wearing rings worn
  - (2) Impeller damaged
  - (3) Internal leakage resulting from defective gaskets.

4. Pump loses liquid after starting:
- a. Suction line not filled with liquid
- b. Air leaks in suction line or stuffing boxes
- c. Gas or vapor in liquid
- d. Air or vapor pockets in suction line
- e. Inlet to suction line not sufficiently submerged
- f. Available NPSH not sufficient
  - (1) Height from liquid level to centerline of pump too great (System 1) or
  - (2) Height from centerline of pump to liquid level insufficient (System 3) or
  - (3) Difference between suction pressure and vapor pressure too small (System 4)
- g. Liquid seal piping to lantern ring plugged
- h Lantern ring not properly located in stuffing box.

5. Pump overloads driver:
- a. Speed too high
- b. Total head lower than rated head
- c. Either or both the specific gravity and viscosity of liquid different from that for which pump is rated
- d. Mechanical defects . . .
  - (1) Misalignment
  - (2) Shaft bent
  - (3) Rotating element dragging
  - (4) Packing too tight.

6. Vibration:
- a. Starved suction
  - (1) Gas or vapor in liquid
  - (2) Available NPSH not sufficient
  - (3) Inlet to suction line not sufficiently submerged
  - (4) Gas or vapor pockets in suction line
- b. Misalignment
- c. Worn or loose bearings
- d. Rotor out of balance
  - (1) Impeller plugged
  - (2) Impeller damaged
- e. Shaft bent
- f. Improper location of control valve in discharge line
- g. Foundation not rigid.

7. Stuffing boxes overheat:
- a. Packing too tight
- b. Packing not lubricated
- c. Wrong grade of packing
- d. Insufficient cooling water to jackets
- e. Box improperly packed.

8. Bearings overheat:
- a. Oil level too low
- b. Improper or poor grade of oil
- c. Dirt in bearings
- d. Dirt in oil
- e. Moisture in oil
- f. Oil cooler clogged or scaled
- g. Failure of oiling system
- h. Insufficient cooling water circulation
- j. Bearings too tight
- k. Oil seals too close fit on shaft
- m. Misalignment.

9. Bearings wear rapidly:
- a Misalignment
- b. Shaft bent
- c. Vibration
- d. Excessive thrust resulting from mechanical failure inside the pump
- e. Lack of lubrication
- f. Bearings improperly installed
- g. Dirt in bearings
- h. Moisture in oil
- j. Excessive cooling of bearings.

ceeds by a wide margin the minimum pressure required in the impeller eye.

If the pump is driven by a steam turbine or other variable speed driver, capacity reduction may be effected by reducing the speed or by reducing the speed and throttling. If the reduction can be effected by a reduction in speed without throttling the discharge, a bypass is not necessary. When constant speed drivers are used, reduction in capacity can only be attained by throttling the discharge and a bypass is necessary.

Pumping at High Temperatures. When the temperature of the liquid to be pumped exceeds 350° F, the pump should be thoroughly preheated to an even temperature throughout. It is recommended that the pump casing be not less than 50° F below the pumping temperatures before the pump is started.

If the pump is started at room temperature, the temperatures of the liquid should be gradually increased over a period of 3 to 4 hours. If this cannot be done, hot liquid should be circulated through the pump for a period of 3 to 4 hours to thoroughly heat the pump before starting.

To be of value, a spare pump for high temperature service must be ready to start instantly and without the possibility of damage as a result of the unequal expansion of parts. If the operating and spare pumps are piped as shown by Figure 35, the spare will always be ready to start instantly without damage to parts.

When keeping a standby pump hot by circulating hot liquid:

1. Cooling water should be circulated through the pedestals and packing boxes.
2. A small amount of liquid should be circulated through the lantern rings.
3. It is recommended that once each shift, the standby be started and brought up to full speed for three or four minutes.

This will:

(a) Help maintain the internal parts and case at an even temperature, and

(b) Wash out any foreign material that may have collected in the pump.

If the standby pump is for hot oil service and the hot circulating oil has a tendency to coke, it is recommended that it be started and run at full speed for 2 or 3 minutes, twice each shift.

During operation, the gate valves in the suction and discharge lines of the spare pump are wide open. This permits hot liquid from the discharge of the operating pump to circulate continuously through the by-pass to the standby pump back to the suction of the operating pump. This circulation will be sufficient to keep the standby pump hot and eliminate the possibility of damage should it be necessary to start the pump instantly.

When starting a hot charge pump, suction conditions may become unstable in the temperature range of 240° to 375° F and cause the pump to lose suction. When this occurs, open the priming valve enough to maintain suction on the pump. As soon as stable conditions are again established, the priming valve should be closed gradually and remain closed unless the pump should again lose suction. CAUTION . . . If the suction temperature is 400° F or above, cold oil must be admitted slowly. A large quantity may cause parts to cool rapidly and result in damage to the pump.

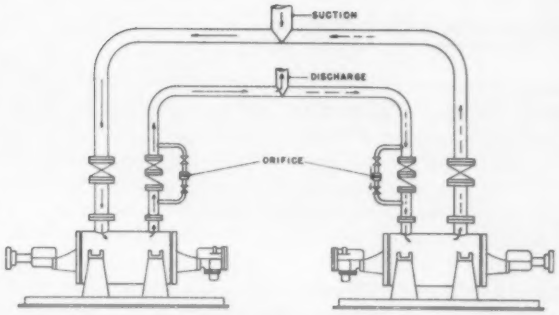

FIGURE 35—If operating and spare pump are piped this way, the spare will be ready to start instantly without damage to parts.

Effect of Speed Changes. Changing the speed of a centrifugal pump changes the capacity, the pressure (head in feet) and the brake horsepower (bhp). The capacity will vary in the direct ratio of the speed and the pressure (head in feet) will vary as the ratio of the speed squared. The bhp will vary as the ratio of the speed cubed except in cases where the speed reduction is such that the efficiency of the pump is reduced. When this occurs, the bhp-speed cubed relationship will not hold.

The percentage of increase or decrease in the rated capacity of a pump may be used to determine the speed as well as the approximate head and bhp at the changed capacity.

New capacity = Rated capacity plus or minus (percent rated capacity × 1)

New speed = Rated speed plus or minus (percent rated speed × 1)

New head = Rated head plus or minus (percent rated head × 2)

New bhp = Rated bhp plus or minus (percent rated bhp × 3)

For example, the rating stamped on the name plate of a pump is:

Capacity—500 gpm	Head 200 feet
Speed—3,000 rpm	Bhp—38.8

What will be the speed, heat and bhp of this pump if we:

(1) Increase the Capacity 10 Percent

	Rated	Change	Approx. New	Actual New
Capacity gpm	500	+ (500×.10×1 = 50)	550	550
Speed rpm	3000	+ (3000×.10×1 = 300)	3300	3300
Head Feet	200	+ (200×.10×2 = 40)	240	242
Bhp	38.8	+ (38.8 × .10 × 3 = 11.6)	50.4	51.3

(2) Decrease the Capacity 5 Percent

	Rated	Change	Approx. New	Actual New
Capacity gpm	500	— (500×.05×1 = 25)	475	475
Speed rpm	3000	— (3000×.05×1 = 150)	2850	2850
Head Feet	200	— (200×.05×2 = 20)	180	180
Bhp	38.8	— (38.8×.05×3 = 5.8)	33	33.2

The values in the column "actual new" are calculated from curve data and are intended to show the

small difference between the approximate and calculated head and bhp. The method of approximating the head and bhp should not be used for changes exceeding 15 percent of the capacity rating stamped on the name plate on the pump. For capacity changes for continuous operation, the pump manufacturer's recommendations together with new performance curves should be obtained.

Specific Gravity Effects. The capacity in gpm and the head in feet of liquid developed by a centrifugal pump are fixed for every point on the curve and are always the same for the same speed. Neither will be affected by a change in the specific gravity of the liquid pumped. Because the discharge pressure in psi and the bhp required to drive the pump are a function of the specific gravity of the liquid, both will be affected in direct proportion to any change in specific gravity.

For example, a pump is designed to deliver 220 gpm of liquid having a specific gravity of 0.75 against 60 psi when operating at 3550 rpm. The discharge head in feet of liquid is $\frac{60 \times 2.31}{0.75}$ or 185 feet, and this head and the speed fix the diameter of the impeller. The bhp required to drive the pump is 11.9. If the specific gravity of the liquid changed from 0.75 to 1.0, the pump would deliver the same capacity and develop the same 185 feet head. However, the increase in specific gravity is $\frac{1.0}{0.75} = 1.33$ and the discharge pressure would be increased 60×1.33 to 80 psi and the bhp increased 11.9×1.33 to 15.9 bhp.

Viscosity Effects. Because viscosity is a measure of the friction between the particles throughout the mass of a liquid, a change in viscosity will effect a change in the capacity, head, efficiency and bhp requirements of a pump. These effects are quite pronounced, especially above 150 Saybolt Universal Seconds (SUS).

An approximate rule cannot be given for calculating the effects of viscosity changes, as they will vary with the size, design details and speed of the pump. In general, viscosities below 150 SUS have very little effect on small pumps. Above 150 SUS, any increase will be reflected by a drop in capacity, head and efficiency and an increase in the bhp required to drive the pump. If a pump has been designed for pumping liquid of 800 SUS and the viscosity drops, the capacity, head and efficiency will increase and the bhp required for driving will decrease.

When contemplating operation at some viscosity other than that for which the pump is designed, the changed conditions should be given the manufacturer and his recommendations obtained.

Vibration. When vibration occurs, look for these causes and their remedies:

1. Starved suction:
   (a) caused by low liquid level. Use the discharge valve to reduce the capacity until normal liquid level is restored.
   (b) caused by the release of air or vapors in the suction. Vent the pump to re-establish full capacity.

If trouble continues:

(1) Check suction line for leaks and for vapor pockets.

(2) Check available NPSH. It may not be sufficient for the capacity.

(3) Check submergence of the inlet to the suction line, air or vapors will be drawn into the suction line if the inlet is not sufficiently submerged.

2. Misalignment will cause steady vibration. Review method of checking alignment of pump and driver. It is assumed the suction and discharge lines are properly braced and adequate provision made for expansion, but if misalignment is of frequent occurrence, the lines and the bracing should be carefully checked.

3. Worn or loose bearings will also cause steady vibration. Check bearings and replace if necessary. (See 5—Shaft bent.)

4. Rotor out of balance usually evidenced by intermittent vibration—remove rotating element—check impeller—if passages clogged, remove foreign material. If impeller damaged, the extent of the damage will determine if repairs can be made or if a new impeller must be installed.

5. Shaft bent—remove shaft—check with dial indicator, straighten, and with dial indicator, recheck for straightness. Should first check show shaft to be straight—check bearings. See 3—worn or lose bearings.

6. Foundation not rigid—vibration is more apt to occur when the unit is mounted on a fabricated structure than when mounted on a concrete foundation built up on firm soil. The only remedy is to reinforce the foundation.

7. Vibration originating in the driver will be transmitted to the pump. Disconnect the coupling and run the driver at full speed. If driver vibrates, follow the manufacturer's instructions for correction.

8. A control valve, improperly installed, will cause line surges which will be transmitted to the pump and cause vibration. The only remedy is to relocate the control valve.

Steam Turbines. Pumps driven by steam turbines demand special operating care. Follow the manufacturer's instructions for warming up and making other details ready for starting.

To insure adequate lubrication of the interior parts of the pump, sufficient pressure differential must be generated so there will be a nominal flow across the close running clearances. Because of this, it is essential that centrifugal pumps be brought immediately up to speed. With motor driven units, this is automatically taken care of. With turbine driven units, open the throttle valve wide as fast as possible so that the turbine comes up on its governor in a few seconds.

To start the pump:

1. Establish circulation of (a) water in cooling system and (b) oil in gland and flushing systems when used.

2. If pump is above the liquid level, close the discharge valve. If pump is below liquid level, open discharge valve 1½ to 2 turns.

3. Prime pump.

4. Start driver and bring pump up to speed.

5. Immediately after the pump is up to full speed and pressure, open the discharge valve slowly to avoid abrupt changes in velocity and surging in the suction line. Operating the pump against a closed discharge valve will cause the liquid in the pump to heat up and result in vapor binding and loss of suction.

6. Check the pump, driver, bearings, lubricating system packing, etc. Check the thrust bearing oil pressure. To obtain the correct pressure, adjust the bypass spring tension. After adjustment has been made, check the pressure from time to time as the pressure may drop as the oil becomes warmer.

7. Check the pressure gauges on each side of the temporary suction screen. An increase in pressure drop, as evidenced by a difference in pressure between the two gages indicates the screen is becoming clogged with dirt and scale. At this point, the pump should be shut down, the screen cleaned and replaced in the line. When the system is free of dirt and scale as evidenced by no further increase in pressure drop across the screen, it may be removed from the line. A suction screen should remain in the line for at least 24 hours under normal capacity-temperature operating before final removal.

8. If there is any indication of trouble, such as heating of bearings, heating of packing, vibration or undue noise, the unit should be shut down at once and an inspection made to determine the cause and eliminate it.

(TO BE CONTINUED)

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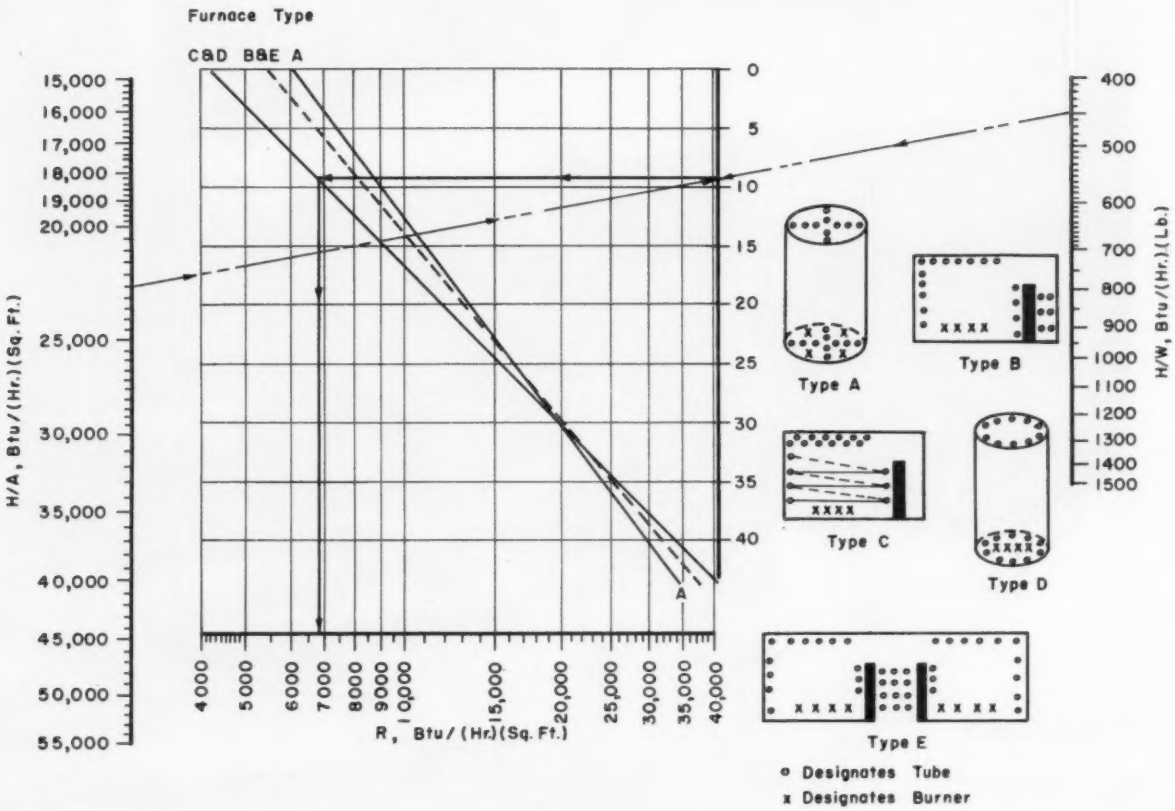


Chart Gives Furnace-Heat Evaluation

If you're a process designer who sometimes needs furnace-heat transfer data without going through rigorous calculations, try this fast, easy method

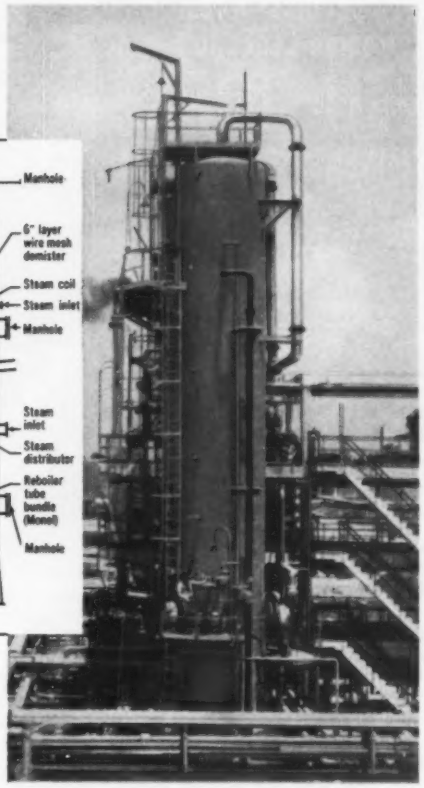
Radiant-heat transfer in five major types of tubular fired heaters has been measured and correlated in equation form by L. J. McCarthy.[1] For more convenient application, these results have been worked into the accompanying chart which represents the original equations within the accuracy needed for most process design by non-specialists in furnaces. These principal variables are interrelated:

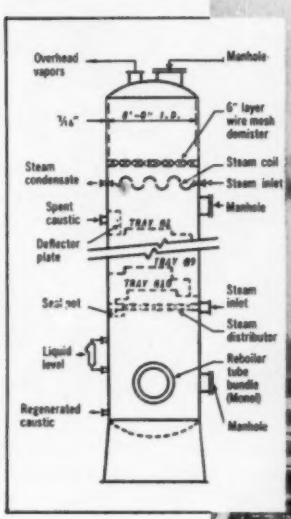
- A, square feet of external tube surface in the radiant section of the furnace.
- H, total enthalpy of the hourly fuel-side charge to the furnace, consisting of the lower heating value (LHV) of the fuel plus the sensible and latent heats of both fuel and combustion air, referred to 60° F.
- R, radiant heat transfer rate, Btu/(hour) (square feet of A).
- W, pounds per hour of combustion products, equal to the pounds per hour of fuel plus combustion air.

Example. Let a type-B furnace be required to transfer 50 million Btu's per hour when burning methane fed at 100° F with 40 percent excess air preheated to 500° F. Find (a) the efficiency of the radiant section if the radiant rate is 12,500 Btu/(hour) (square feet), and (b) the surface and radiant rate needed if the radiant section efficiency is required to be 80 percent.

Solution. Part (a): From the stoichiometry of the process, the air charged

Here's the case history you saw in Petroleum Refiner, December, 1955...





New solid Monel caustic stripper. Old tower was a conventional Raschig-ring-packed, 9 ft. diam. tower with walls clad or lined to 20 per cent of thickness with Monel nickel-copper alloy. New tower is 8 ft. diam. bubble cap tower with 7/16 in. solid Monel walls and a wire mesh coalescing demister installed above the feed tray. New unit reduces maintenance materially. It eliminates ring dust and reduces caustic carryover, saving about 75,000 lbs. per month. It gives a far "sweeter" product, cutting after-treating reagent use in half. Tower response to process changes is also greatly improved.

New caustic stripper is solid Monel

and here's the story up to date...

When a vessel must withstand corrosive 47° Baumé caustic at 290° to 300°F., it needs all the protection it can economically obtain.

That was the conclusion reached by engineers of Cities Service Refining Corporation's Lake Charles refinery when they had to replace the caustic stripper in their Unisol unit. The stripper had originally been built using Monel* nickel-copper alloy claddings or linings comprising up to 20 per cent of the vessel wall thickness. That was when wartime restrictions had made it difficult to obtain sufficient quantities of the solid alloy.

When the decision came to replace it, the design was also revised as operating experience suggested.

Goes right back to Monel

This time Cities Service is using 7/16" solid Monel nickel-copper alloy.

They reason this way. Monel remains one of the most resistant of all materials to conditions encountered in caustic regeneration. The 7/16" wall can be expected to give years of trouble-free service. What's more, solid Monel is easy to fabricate. If repair is needed, a relatively simple welding job will handle it.

Cities Service is also using this nickel-copper alloy for hot caustic lines, heat exchangers and the internal reboiler tube bundle.

Caustic corrosion is seldom a clean cut problem with an easy answer...but nickel or nickel alloys like Monel will usually handle it. That's why Inco's Corrosion Engineering Section is one of the first places to go for advice and suggestions. So if you are having trouble, write today . . . giving full details.

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This caustic stripper was shut down for annual inspection on June 15, 1959. It had handled a 45% (47° Baume) caustic stream at 290° to 300°F since October, 1954.

Audiogauging showed no detectable metal loss from the 7/16-inch Monel* alloy walls.

Cities Service reports that the excellence of Monel alloy in this stripper tower led to its use in the lines, pumps, and valves of the unit.

The other caustic stripper in the refinery will soon be replaced with a Monel alloy tower. You can see why. Monel alloy shows excellent resistance to caustic attack over a wide concentration and temperature range. It is readily fabricated and welded. What's more it's readily available, often from warehouse stocks.

Want the full story? Our 24-page illustrated Technical Bulletin, "The Resistance of Nickel and its Alloys to Corrosion by Caustic Alkalies," covers practically everything you'll want to know about handling caustic soda. Write for your free copy today. Ask for Bulletin No. T-6.

*Inco trademark

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
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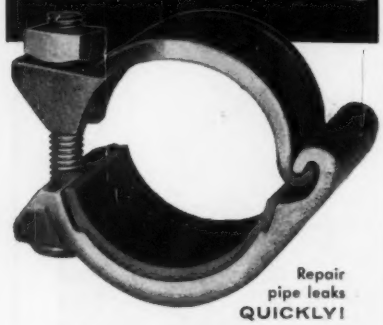
MONEL®

For Speediest Repair of Corrosion Leaks in Pipe

JUNIOR

EMERGENCY PIPE CLAMP

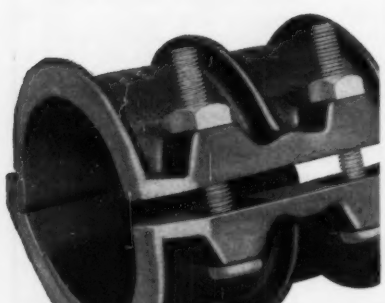


Repair pipe leaks QUICKLY!

Speediest application — slotted lug permits the single plated bolt to slide instantly into place.

A companion to the old reliable Emergency Pipe Clamp that has served industry for a half century, the JUNIOR, a single bolt clamp, is 2⅞" wide. Undersells most band-type clamps.

Made of malleable iron, ruggedly proportioned, with full-length hinge along one side. Formed to exact pipe size—no bending. The recessed pressure-equalizing gasket, entire width of clamp, is cemented in. A lasting installation. 2" pipe size—$1.80; 2½"—$2.20; 3"—$2.30. Write for new circular on the Junior.



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EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

Send for catalog!

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How To Do It . . .

is 20.0 lb/lb fuel. Also:

Charge enthalpy = 21,500 + 0.54 (100-60) + 20(0.245) (500-60) = 23,670 Btu's per pound of fuel.

H/W = 23,670/(20 + 1) = 1,130 Btu's per pound of combustion products.

A = 50,000,000/12,500 = 4,000 square feet.

From the chart, for the required H/W and R, H/A = 16,500. Consequently

H = 16,500 (4,000) = 66,000,000 Btu's per hour.

Fuel charged = 66,000,000/23,670 = 2,780 pounds per hour.

Efficiency = 50,000,000/(2,780) (21,500) = 0.836, or 83.6 percent.

For part (b),

Fuel = 50,000,000/(0.80) (21,500) = 2,910 pounds per hour.

H = 2,910 (23,670) = 69,200,000 Btu's per hour.

H/W = 23,670/21 = 1,130 Btu's per pound of combustion products.

With this value of H/W, corresponding trial values of H/A and R are read off the chart until a set is found that satisfies the relation

$$A = \frac{69{,}200{,}000}{H/A} = \frac{50{,}000{,}000}{R}$$

By this procedure the sought values are found to be A = 3,450 square feet and R = 14,500 Btu/(hour) (square feet).

A complete furnace design requires also the evaluation of the convection section. Suitable procedures are given by Donald Kern.[2]

This item was submitted by S. M. Walas, the C. W. Nofsinger Co., Kansas City, Mo.

LITERATURE CITED

[1] McCarthy, L. J., "Radiant Design of Heaters," Chemical Engineering Progress, 52, No. 3, P 97 M (1956).
[2] Kern, Donald, "Process Heat Transfer," McGraw-Hill Book Co. (1950).

Welding Jig Makes Pipe Fabrication Much Easier

Pipe fabrication is sometimes a difficult job, especially when heavy fittings have to be manhandled. Welders are often forced to work in awkward positions, increasing the possibility of a smashed toe or strained back.

Welders with Panhandle Eastern Pipe Line Co. developed an idea that

takes the work out of fabrication and improves the safety factor considerably. The fitting to be welded (in this case, a tee and an ell) can be tack welded, lifted to the device by an overhead crane and locked in place by bolts at the sides, as shown in the photograph. As the welder's helper turns the wheel, which is offset and counter-weighted for better maneuverability, the welder can complete his work without having to change positions.

The device shown here is used for fabricating 10 and 12-inch pipe and fittings. Another rig for working with smaller diameter pipe is mounted on a movable table. Using the smaller rig, the welder can turn the pipe with one hand while welding with the other.

These jigs were made almost entirely from scrap steel, including the large wheel which was salvaged from an old gate valve.

This idea and photograph submitted through the courtesy of *Panhandle Lines,* a publication of Panhandle Eastern Pipe Line Co.

Hook Holds Load For Tube Rolling and Grinding Jobs

Where heavy tools and equipment must be held against an emery wheel, a sky hook such as the one shown will change the job from a gruelling task to a pleasant job.

A weight slides up and down inside the stand and the part to be handled is hooked to the wire line dangling from the front of the beam. This device was originally designed

another
TRETOLITE SERVICE
report

BEFORE KONTOL! *Here's what a tube bundle looked like in one of the heat exchangers of an Ohio refinery — after just 94 days of service. A* KONTOL *Protection Program has since trebled tube life, upped heat exchange efficiency by more than six million BTU's per hour!*

KONTOL* CORROSION INHIBITOR TRIPLES TUBE-BUNDLE LIFE AT OHIO REFINERY

Also saves $96.00 per day on increased BTU's . . . The effectiveness of KONTOL* protection against corrosion and fouling in tube bundles was dramatically demonstrated in the heat exchange equipment of the crude unit at a large refinery in Ohio.

Since the inauguration of a regular KONTOL Corrosion Inhibitor program, the tube bundle life period has been increased by approximately 3 times the bundle life prior to the use of KONTOL.

KONTOL'S DETERGENT ACTION ADDS DOLLAR-BONUS TO OPERATION

The detergent action of KONTOL Corrosion Inhibitor provided a *plus* benefit for the refinery. A cleaner operation has resulted in the gain of an additional 6,000,000 BTU's per hour—or a savings of about $96.00 per day.

THERE'S A KONTOL PRODUCT FOR YOUR CORROSION PROBLEM

The KONTOL product used in this case was based on a careful study of the refinery's specific needs. The Tretolite Company developed and pioneered the application of organic corrosion inhibitors throughout the petroleum industry. No other organization has Tretolite's wealth of experience and know-how in the manufacture and use of these products. This background (Tretolite corrosion engineers, laboratory and research facilities) is always available to you—to help solve your particular corrosion problems. A call will bring you this service—at no obligation.

*KONTOL *is a registered trademark of Petrolite Corporation.*

KR-59-1

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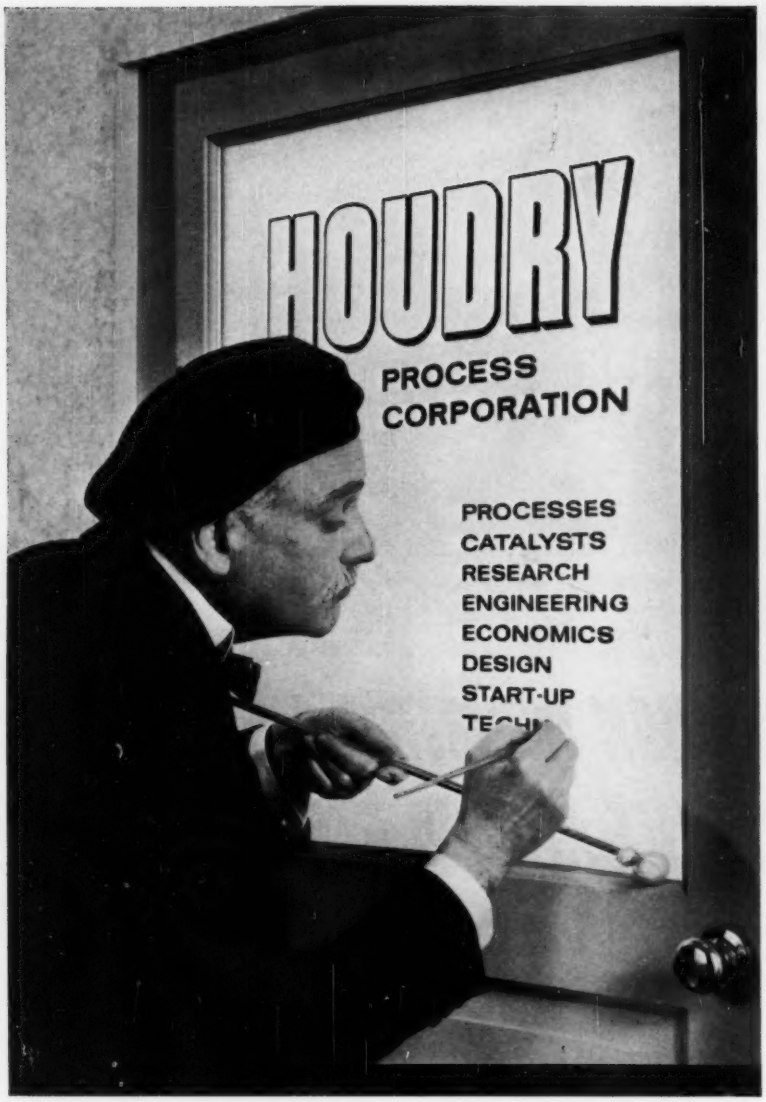

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Availability of contract research, for instance, enables processors to "farm out" projects ranging from development of theories to pilot plant tests of processes and chemicals. Houdry contract technical service helps keep plants operating at peak performance levels.

And while you may contract for one or more *specific* services, you can often derive additional direct benefits from *other* services and other phases of Houdry's operations at the same time. Your contact with any section of Houdry's technical service group also makes the experience and knowledge of the *whole* group available for application to your requirements.

Have you checked into Houdry's services lately? There's never been a better time. Write for an up-to-date description of Houdry services today.

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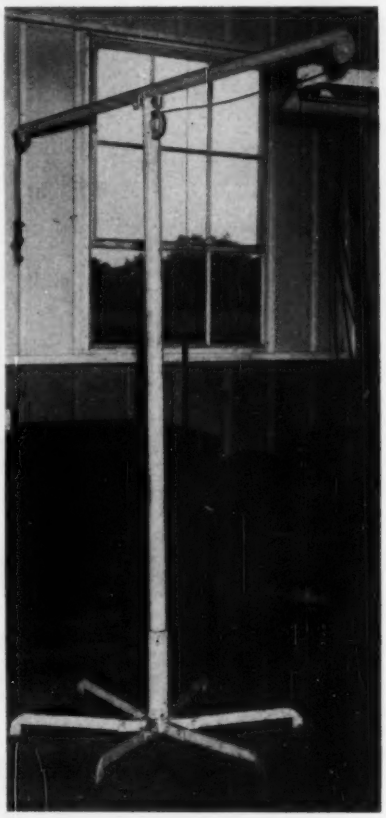
*Houdry means Progress . . . through Catalysis

How To Do It . . .

to support an electric motor for rolling out heat exchanger tubes. But it was found that when the counter-



balance was not in use for tube rolling, it could be placed in front of a large emery wheel for instant use for grinding off heavy pieces.

YOUR IDEAS ARE VALUABLE!

At least $10 will be paid for each idea accepted for "How to Do It." Just send a brief note with a photo or sketch to the Editor, *Petroleum Refiner*, P. O. Box 2608, Houston.

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This hypodermic could help cure your ailing gas conditioning system

This could be *your* sample ethanolamine solution that is being injected into a gas chromatograph for chemical analysis. This is just one of the many methods used by Jefferson's extensive research laboratories in Austin, Texas, to help you solve your gas processing problems. A wealth of technology and experience in such problems as high temperature corrosion, contamination, foaming characteristics, and excessive glycol losses is available expressly to serve your needs.

And whatever the findings, Jefferson has the *right* chemicals to meet your requirements in natural gas sweetening, refinery stream sweetening, sulfur recovery, carbon dioxide absorption, gas dehydration and hydrate prevention.

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HI-DRY® Liquid Desiccant

HI-DRY, Jefferson's special grade tetraethylene glycol, will give you the *extra* dew point depression so often needed in the dehydration of higher temperature gas streams.

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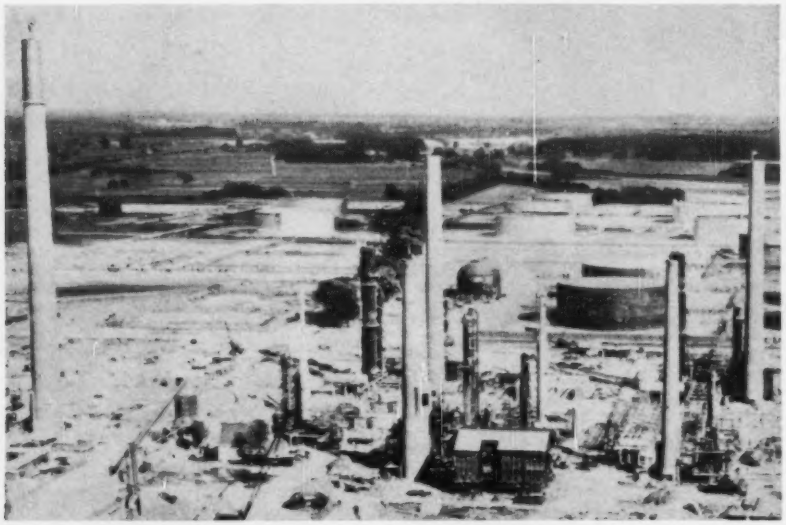
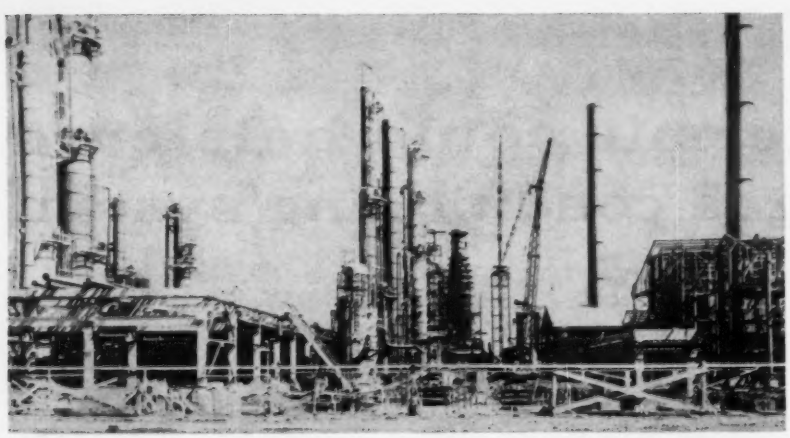
Who's Building...



New BP German Refinery Near Completion

By the middle of this year British Petroleum Co.'s third refinery in Germany should be operating. Already many towers of the processing units, as well as storage tanks and buildings have been erected. Situated near Dinslaken, 15 miles north of Duisburg, the refinery will process 4.4 million tons of crude oil a year. BP already has two refineries in Germany, one with a 2 million ton per year capacity at Hamburg—the other a smaller one with a 220,000 ton per year capacity.

A wide range of products from the new refinery will include high-grade gasoline, aviation turbine fuels, marine diesel oils, gas oils, fuel oils and petroleum chemical feedstocks. Crude oil will be supplied to the refinery by the Wilhelmshaven/Rhur pipeline. Products will be distributed by rail, road and water. A harbor for Rhine barges is being built about three miles from the refinery. The harbor, which will accommodate four barges, will be connected to the refinery by pipeline through which products will be pumped.



More Capacity for Canada at Ville d'Anjou

British Petroleum Canada, Ltd., will complete its new 25,000-bpd refinery at Ville d'Anjou, Que. in spring 1960. The $30-million project will include a 15,000-bpd fluid catalytic cracker, 6,000-bpd Platformer, 9,000-bpd catalytic reformer, 12,000-bpd hydrodesulfurization unit, 800-bpd polymerization unit, and a crude distillate unit. Many of the processing-unit towers have been erected, plus 22 of the refinery's tanks, ranging in capacity from 1,500 to 10,000 tons. Lummus Co. of Canada is handling construction of the plant.

Great Northern Oil Co. has started construction of Minnesota's first sulfuric acid alkylation plant. The unit will be situated at the company's Pine Bend refinery site, south of the Twin Cities. When completed in mid-1960, the plant will enable the company to produce its own alkylate and maintain more rigid quality control of products.

Costing more than $1 million, the unit will occupy a two-acre plot within the refinery proper, immediately east of the existing main processing area. Its beginning capacity will be 1,500 to 2,000 bpd, with ultimate capacity of about 3,800 bpd.

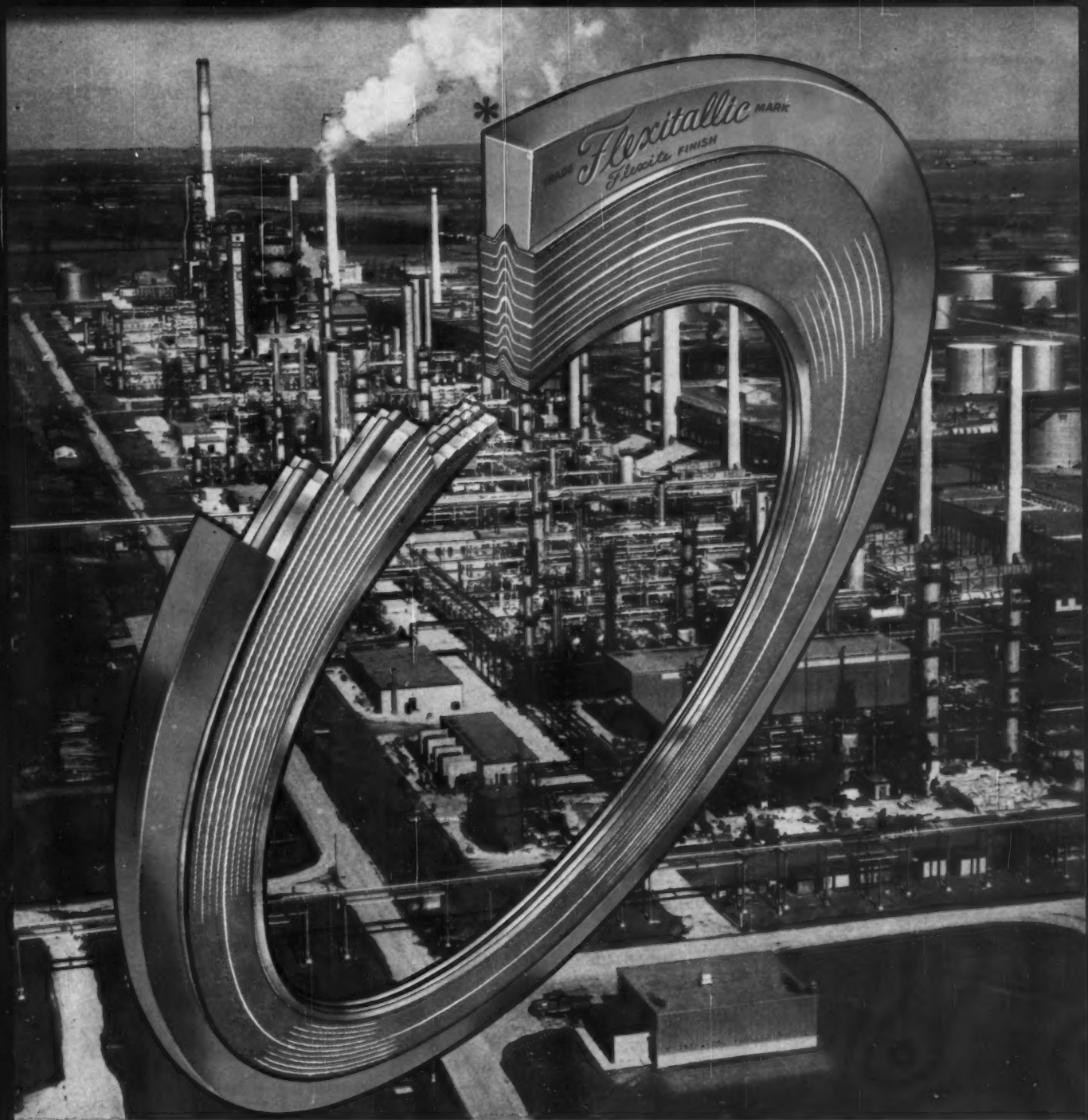
Facilities to be built include a 180-foot high fractionating tower—largest of its type in the Northwest; a furnace, control house, pump house, cooling water tower, heat exchange equipment and pumps; and gas compressor. Storage facilities will include three spherical tanks of 18,000 barrel capacity and four acid storage tanks, with capacity of 1600 tons. Tankcar loading and unloading facilities for isobutane and butane mixtures will also be provided.

The Refinery Engineering Co., Tulsa, handled process and mechanical design and engineering, and will also construct the plant. The new unit will make possible a single processing step of feed preparation and depropanization, eliminating the need for separate debutanizing facilities for control of vapor pressure. The plant has been designed so there will be no contribution to water or air pollution.

Monsanto Chemical Co. plans to increase production of styrene monomer by at least 200 million pounds a year. The first stage of the new $30-million facilities, to be located in the Texas Gulf Coast area, is expected to be in operation by the first quarter of 1961, and the second sometime in 1962. The new facilities will be built in two stages, each having an annual capacity of about 100 million pounds each. The company hasn't acquired the plant site yet and hasn't decided whether to locate in Texas City or elsewhere.

Davison Chemical Co. has awarded Leonard Construction Co., Chicago, a contract to engineer and construct a contact sulfuric acid plant at Bartow, Fla. The plant, which will have an initial rated production capacity of 400 tons per day with built-in facilities for additional expansion as required, will use elemental sulfur as a raw material. The acid will supplement. Davison's present production of fertilizer materials. Construction will begin immediately, with completion scheduled for August 1960.

Shell Oil Co. plans to complete new asphalt producing facilities at its Norco, La., plant. The new equipment will enable the Norco refinery to produce and stock increased quantities of asphalt



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The gold Flexite Finish* for the metal gauge rings in Flexitallic Compression-Gauge Gaskets is new. It is highly corrosion resistant when exposed to severest weathering in open construction projects or in stock. The Flexite Finish provides for ease of identification and a clean, long-lived installation. Write for samples.

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TRADE Flexitallic® MARK
SPIRAL-WOUND GASKETS
WITH Flexite FINISH

*The gold Flexite Finish is a development of the Flexitallic Gasket Co. (Originators of Spiral Wound Construction) – Register applied for on both name and color. Flexitallic Blue is our exclusive blue-dyed Canadian asbestos filler. Look for the blue and gold color combination as the mark of Flexitallic quality.

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THERE'S A REASON why more and more Motorpumps are being specified today in all types of industry:

Only the Ingersoll-Rand Motorpump combines proven features with modern design engineering that provide rugged dependability, highest pumping efficiency. Motorpumps give you ease of installation, low cost operation and minimum maintenance.

To meet your particular requirements, Motorpumps are available in the widest range of sizes and types. Capacities go from 5 to 2800 gallons per minute; heads to 650 feet. Write today for the latest bulletin.

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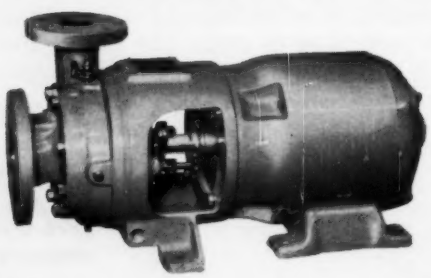


Building . . .

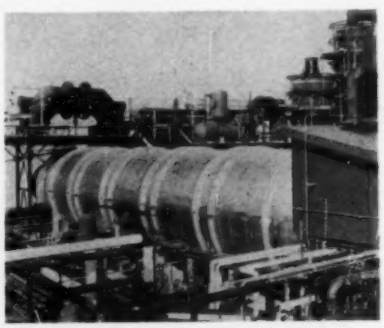
from basic materials already available. The new equipment will be:

- An asphalt blender for mixing two asphalt components.
- A 20,000-barrel storage tank for one of the components and two 35,000-barrel tanks for storage of the end product.
- A steam generator for cooling the product for storage.
- A special insulated pipe line leading from the blender to the storage tanks and from there to the Norco wharf. This line is designed to maintain the asphalt at a high temperature so that it may be transported.
- A pump for loading the asphalt on the ships at Norco's wharf on the Mississippi River.

The primary aim of the expansion program is to provide the refinery with a method of loading sea-going tank ships for hauls to the Eastern United States where there is an increasing demand for the product. At present the entire Norco asphalt output is sold to local markets and is transported by railroad tank cars and tank trucks.

Gigantic Acid Plant for Dixon Chemical Industries

Dixon Chemical Industries, Inc., has completed what it says is the largest sulfuric acid plant of its kind in the world. The $5-million plant can produce 300,000 tons of sulfuric acid a year. It is situated on the Delaware River, directly across from the Philadelphia airport. The new plant is the start of an

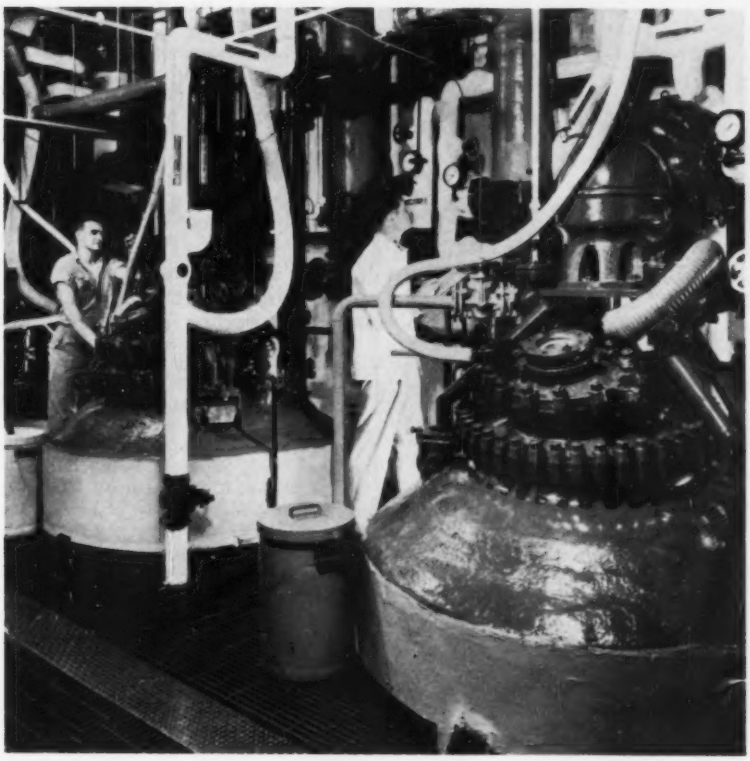


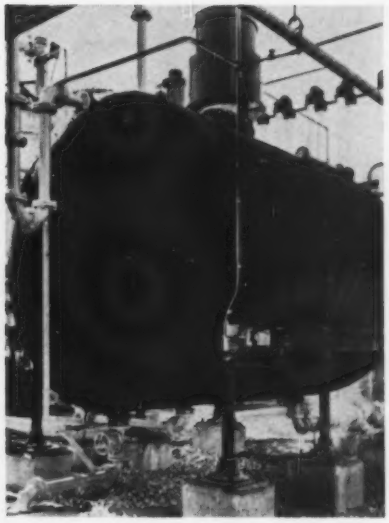
expansion plan to build a chemical complex on the Dixon 70-acre industrial site at Paulsboro.

Late in 1960, Dixon Chemical expects to start-up a new $4-million hydrofluoric acid plant at the Paulsboro complex. Upon completion of this facility next year, total company operations there should represent a $17.5-million investment. The new Paulsboro plant will produce sulfuric acid from acid-bearing sludge obtained from oil refining processes, and will also produce acid from dry or molten sulfur. Output from this plant will serve refineries and other industrial users in the Delaware Valley.

Monsanto Chemical Co. has completed a new polyethylene plant at Fawley, England. Using a high-pressure proc-

FLUIDICS* AT WORK





Solve all 3 corrosion problems with GLASTEEL REACTORS

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2. Variables in the process

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You can put an end to *all* these problems when you use GLASTEEL reactors.

That's because GLASTEEL 59, as fabricated into reactors by Pfaudler, can handle all acids (except hydrofluoric) and mild alkalies *without corroding.*

GLASTEEL is also resistant to thermal shock (260°△T at a vessel temperature of 250° F.) and can be used for processing at temperatures up to 450° F.

You will also find that GLASTEEL interiors are *smooth,* inhibiting build-up that might interfere with processes or cause difficulty in cleaning.

You pick reactors to meet your size and pressure needs. The *P Series* is available in five to 100 gallon sizes, 25 psi—with 150 psi through 50 gallons. The *E Series* covers the 50 to 2000 gallon range with pressures of 25 psi – and with 50 psi and 100 psi through 750 gallons. If your needs take in 300 to 4000 gallon capacities, the closed-top *R Series* at 100 psi is for you.

Other materials: You can also obtain from Pfaudler a complete line of reactors in stainless steel and other alloys. And we now can offer you reactors fabricated from wonder metals —tantalum, titanium, and zirconium.

Write for more specs on any or all types. Bulletin No. 927 (P series), No. 971 (E Series), No. 960 (R Series) and No. 978 (Wonder Metals).

Now cut costs of storing corrosives in large volumes

If you work with volumes between ten and thirty-five thousand gallons, you actually pay less for storage in GLASTEEL Chemstor Tanks than for storing in stainless steel.

At smaller volumes savings are realized through long-term service life when corrosives are involved.

Twenty-five years' service life is not unusual for GLASTEEL storage tanks.

It's the GLASTEEL that handles the corrosion and also makes for ease in cleaning. GLASTEEL is smooth, so there's good resistance to build-up or adherence. And since GLASTEEL does not react with what you store in it, product purity is never a problem.

Choose from horizontal or vertical tanks. Get the story in greater detail by asking for Bulletin 975.

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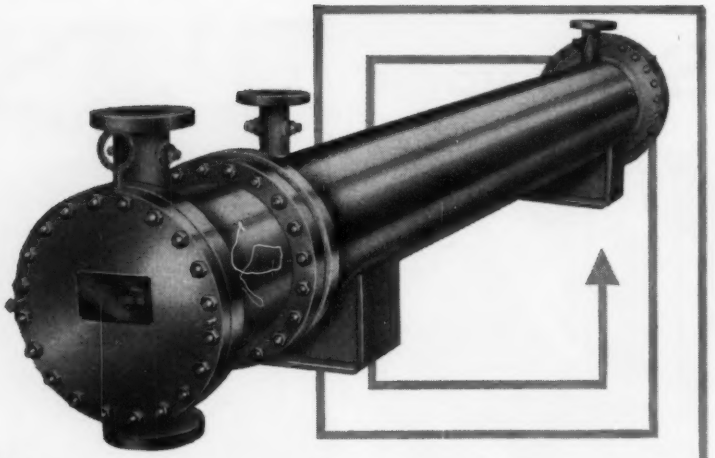
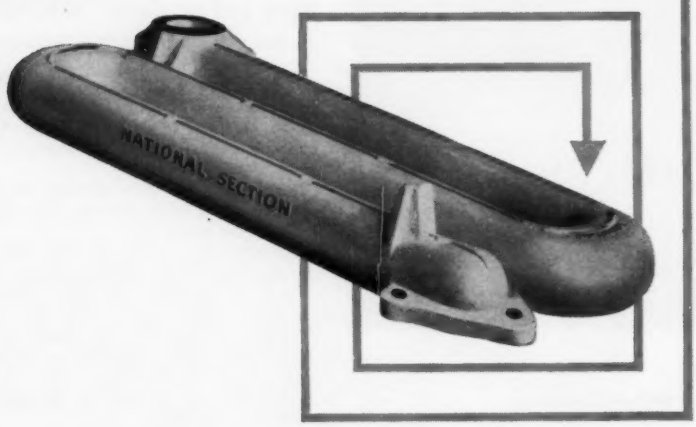


2 Ways to Transfer Heat



Problems of heat exchange and process cooling in the chemical and petroleum industries are best solved when limitations of specific materials, shapes and fabrication methods are reduced to a minimum.

When National-U.S. engineers are called in early enough, they are frequently able to apply an unusual solution to a particular problem, because of their wide range of experience over a broad spectrum of industry. And *only* National-U.S. can offer *both* conventional heat exchange equipment in a complete range of metals *plus* units built from assemblies of corrosion-resistant cast iron.

For details, see REFINERY CATALOG or contact . . .

58-01

Heat Transfer Division

National-U.S. Radiator

CORPORATION

342 Madison Avenue • New York 17, New York

Building . . .

ess, it is making a range of polyethylenes at a rate of 10,000 tons per year, and production facilities are already being expanded. The $9-million plant, said to be the only one of its type in Southern England, is adjacent to the Esso Petroleum Co. refinery, from which it receives ethylene made in Esso's recently completed polyethylene plant. In addition to the main plant, the Monsanto unit has a pilot-plant reactor system capable of accurately simulating full-scale working conditions. It will be used to extend the range of production by developing specialized materials, and to increase the efficiency of operations.

Texas Eastman Co. plans to build a new polypropylene plant at Longview, Texas. This production unit will have a designed capacity of 20 million pounds annually and will use a process invented in Eastman's laboratories. The company began commercial production of polypropylene on a limited scale last September. Polypropylene will continue to be available from Eastman in limited quantities until the new plant is in operation. Design for the initial unit of the plant is already under way and construction will be started in early 1960. This unit is expected to begin production in the fourth quarter of 1960 and to reach a volume of approximately 20 million pounds annually about midyear 1961.

Bureau of Mines has started operation of its Keyes, Okla., helium plant, under construction since November 1958. Designed to produce 290 MMcf of helium a year, the plant is expected to reach full-scale production soon. Its output, added to that of four other helium plants now operated by the Bureau of Mines, brings the government's total annual helium production to about 600 MMcf per year. The new plant, which will process natural gas from Cimarron County, Okla., reflects latest technical improvements in helium-extraction methods leading to 99.995-percent-pure helium. The Fluor Corp. built the Keyes plant under an $8.9-million contract. In all, the installation will represent a total investment of approximately $12 million, which includes the site and certain plant additions arranged separately by the Bureau of Mines.

Shell Co. of Singapore, Ltd. plans to build a refinery on the Malayan Peninsula, State of Singapore. The Shell Co. of the Federation of Malaya will build a similar plant in Malaya. The Singapore refinery, which will cost about $13.3 million, has been the subject of discussions with the Singapore Government, and official application has been made to the Minister of Finance for pioneer status for this project. A detailed economic study of the refinery projected for the Federation of Malaya was made earlier this year and discussions with the Federation Government have been in progress for some time. Official application for pioneer status for the project has also been lodged with the Malayan

For more data on advertised products, use Readers' Service Cards, last page.

M·A·N

The following are some of the products we design and manufacture:

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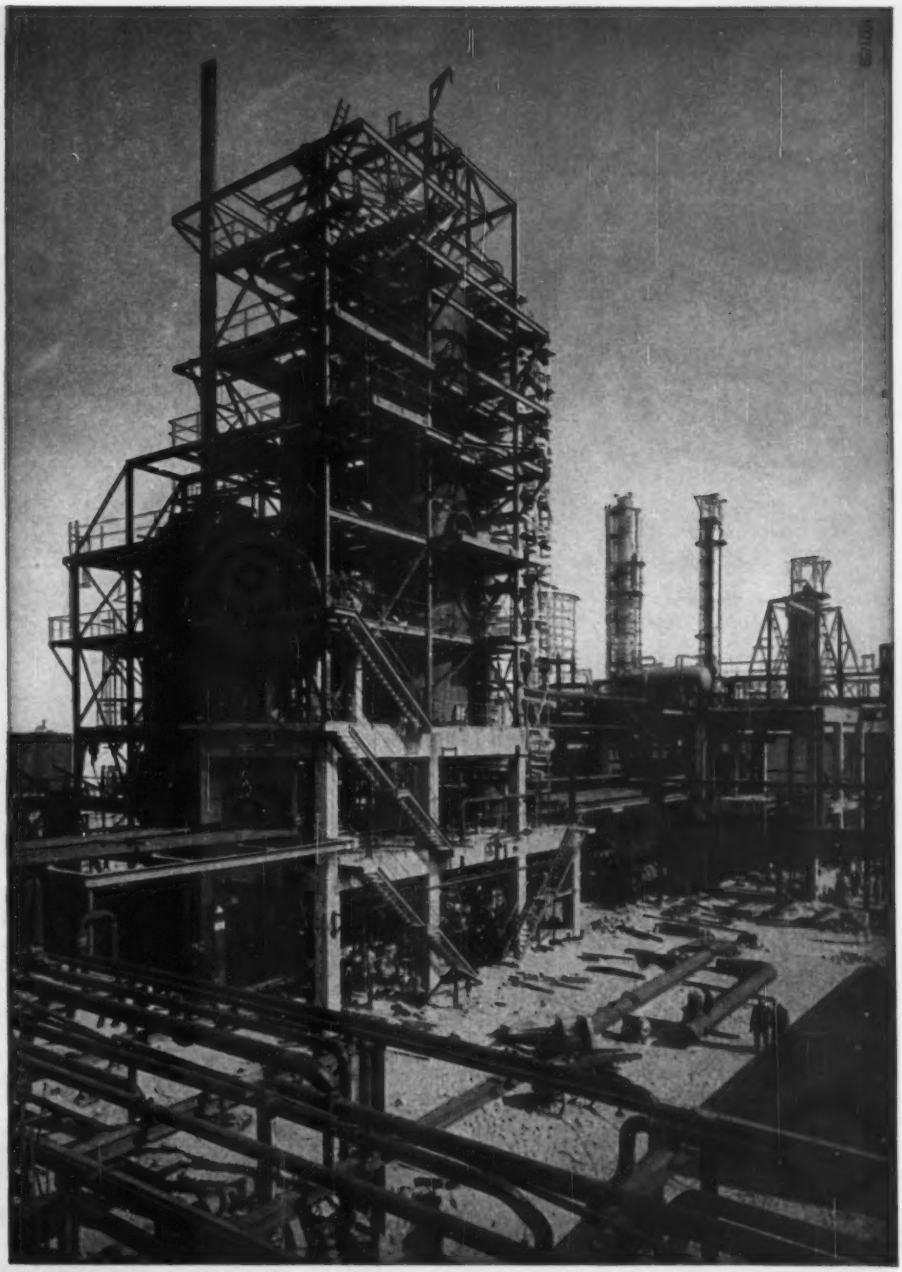

Responsible for process and engineering were:
N. V. de Bataafsche Petroleum Mij., The Hague
and Lummus Nederland N. V., The Hague.
Responsible for purchasing was:
Edeleanu GmbH, Frankfurt.

We recently supplied and installed all apparatuses and structural steelwork required for the

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New Improved JERGUSON Gage Illuminator

gives up to 3 times the illumination

Low cost explosion-proof lighting of entire gage glass with no glare or blind spots

Easily mounted on back of Transparent Gage.

New Features:

Simplified Relamping . . . loosen one thumb screw to lift out cover and glass housing in one piece.

New Safety Chain prevents accidental dropping.

Now both UL and CSA Approved.

The New Jerguson EPL-56 Illuminator gives three times the illumination (and 3 times the bulb life) . . . a bright, evenly diffused light over the entire length of gage glass, thus enabling you to see the liquid level clearly and easily under all conditions. Relamping is simplified: one turn of the thumb screw and you lift out cover and glass housing in one piece.

Jerguson Illuminators incorporate the principle of solid wedge lighting. Illumination from a single bulb is reflected from the angular surface of the plastic wedge and is evenly diffused through the transparent gage glass.

Jerguson Illuminators are UL approved and are built in accordance with their Standard for Electric Lighting Fixtures for use in hazardous locations for Class 1, Group D Services. They are made in a variety of sizes.

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Building . . .

authorities. This plant will cost about $20 million. Both refineries will be designed to meet Shell's present and future local requirements of principal petroleum products. Upon completion, the plants will give permanent employment to several hundred Federation and Singapore nationals and train them in the techniques of refinery operations.

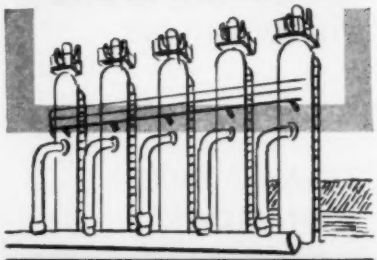
The Dow Chemical Co. will construct a phenol plant with a capacity of 36 million pounds per year in the Pacific Northwest. The plant will be built at a location still to be selected on deep water at Puget Sound, or in the Longview, Washington, or the Portland, Oregon, area. Options on some sites have been secured and others still are under study. Several million dollars will be spent on property development and plant construction before operations begin early in 1961. The plant is the first step in the planned development of an integrated chemical and plastics manufacturing operation in the Northwest. This integrated operation will be built over a period of several years to produce materials important to the region's growing economy.

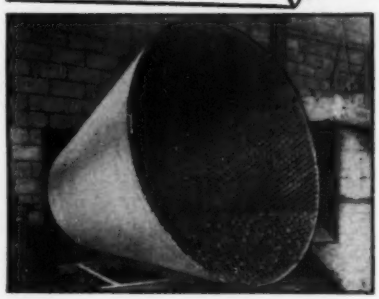
Standard Vacuum Oil Co. is planning two projects which involve what is claimed to be the largest investment of American private capital in Malaya to date. The firm plans to set up an oil refinery and chemical fertilizer plant as part of its $300-million investment program in Malaya. Although proposals have been made to the government, the plans are not yet final, an official said in New York. The refinery would meet Stanvac's present and future needs of principal petroleum products. The company is associating with the Wah Chang Corp. of New York to build the fertilizer plant which would be capable of meeting local nitrogenous fertilizer needs.

Texas Alkyls, Inc. has brought on stream the first U. S. plant for the commercial production of aluminumtrialkyls via the Ziegler process. Located on the Houston Ship Channel, the facility was originally scheduled to have a rated annual capacity of about a million pounds of aluminumtrialkyls. Process improvements incorporated in the design have more than doubled that capacity rating. Currently, the Texas Alkyls project, which is owned jointly by Hercules Powder Co. and Stauffer Chemical Co., is producing triethylaluminum and triisobutyaluminum. The company plans a production expansion early next year which will include the manufacture of ethyl aluminum sesquichloride, diethyl aluminum chloride, and other alkyl aluminum hydrides and chlorides, and higher (C_6, C_8, C_{10}) aluminumtrialkyls.

SunOlin Chemical Co., North Claymont, Del., plans to expand facilities to include the manufacture of ethylene. The new plant will cost approximately $15 million, and ultimate capacity will be nearly 200,000 pounds a year. A portion

FEWER "TURN-AROUNDS"





Shutdowns for repairs of cement linings are expensive. The frequency and duration of these shutdowns can be greatly reduced by the use of a steel grating armor known as "Gridsteel," which holds the castable linings in place longer and armors them against the bombardment of catalytic particles.

"Gridsteel" is available in a special loose clinch to conform easily to curved surfaces.

For complete information, write for brochure on Irving "Gridsteel" Contour Retainer Mesh

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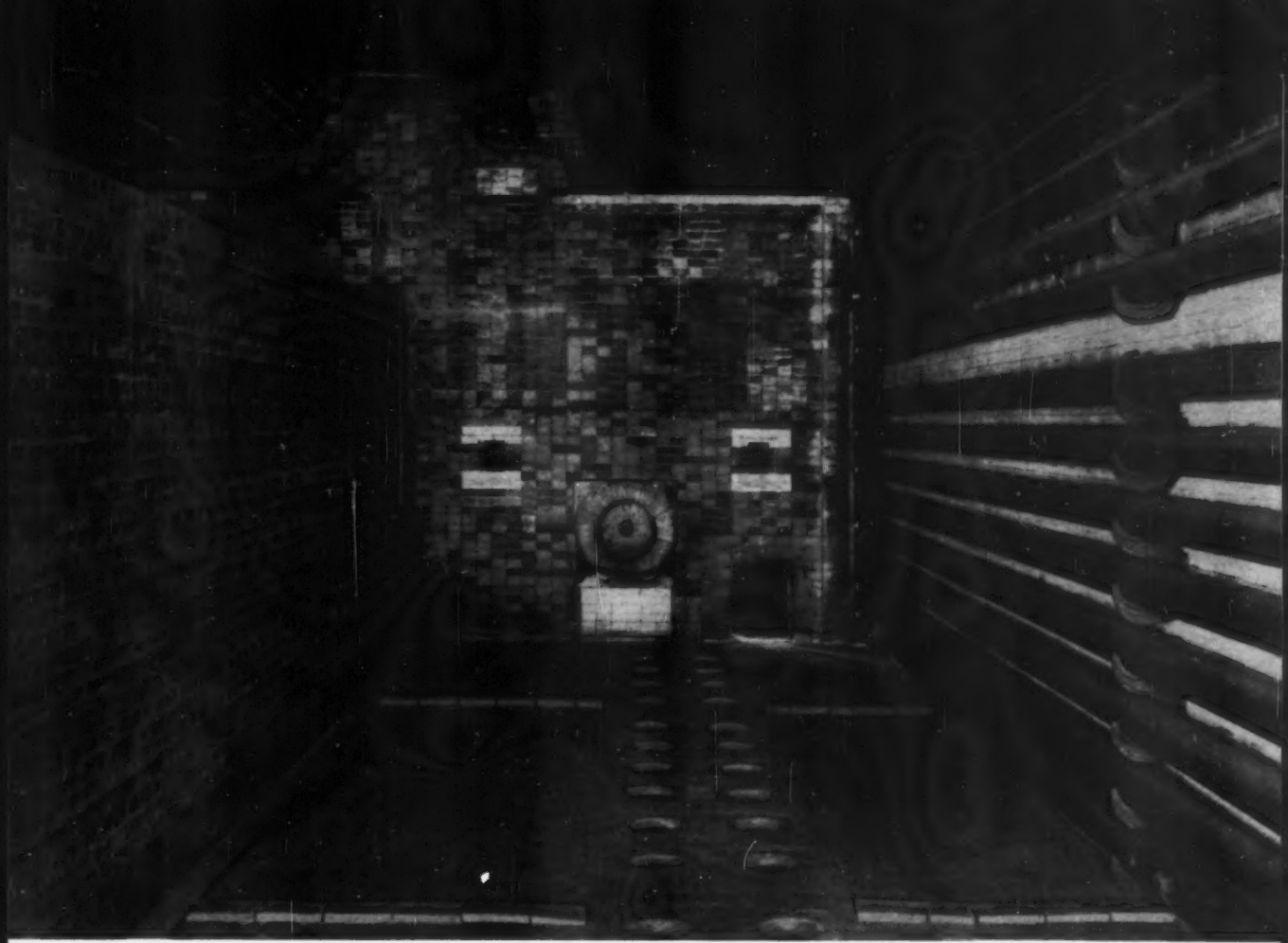

Interior of Oil Heater Lined with B&W Insulating Firebrick.

B&W Refractories stay on stream

Long refractory life, low furnace maintenance, and dependable service result from the use of B&W Refractories. B&W offers a wide line of *specialized* refractories *engineered* to give you maximum furnace availability and economy.

Naturally, the refractory selected depends on the specific service. B&W Insulating Firebrick, for example, serve a dual role. First, these durable, lightweight IFB are most efficient insulators, and second, they withstand direct exposure to furnace heat. This means . . .

REDUCED CONSTRUCTION COSTS—The lightweight and high insulating value of B&W IFB combine to lower material costs and simplify furnace design. Because they withstand furnace heat, they eliminate the need for dense refractory constructions backed up with insulating materials. This, together with lightweight, means thinner, lighter wall constructions, often providing savings in structural steel and foundation costs.

REDUCED OPERATING COSTS—The high insulating value of B&W IFB means savings in everyday operation. Per inch of thickness, B&W IFB provide more insulation than any other refractory lining. Less heat is lost, casing temperatures are lower, working conditions are improved and efficiency is increased.

Furthermore, since B&W IFB are light in weight, they store and conduct less heat. Heavy refractories retain heat; in the event of forced shutdown, they can cause burn-out of expensive alloy tubes, where used. The low quantity of heat stored by B&W IFB can be quickly dissipated, thus protecting these expensive tubes.

This low heat storage also permits faster heating and cooling. This means quicker access to the furnace in the event of emergency shutdown. Your maintenance crew can get in the furnace sooner and get it back on stream faster.

Consult your B&W Refractories Representative for assistance with your refractories problem or write to The Babcock & Wilcox Company, Refractories Division, 161 East 42nd Street, New York 17, N. Y.

B&W

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REFRACTORIES DIVISION

R-628

B&W Firebrick, Insulating Firebrick, and Refractory Castables, Plastics, Ramming Mixes, Mortars, and Ceramic Fiber.

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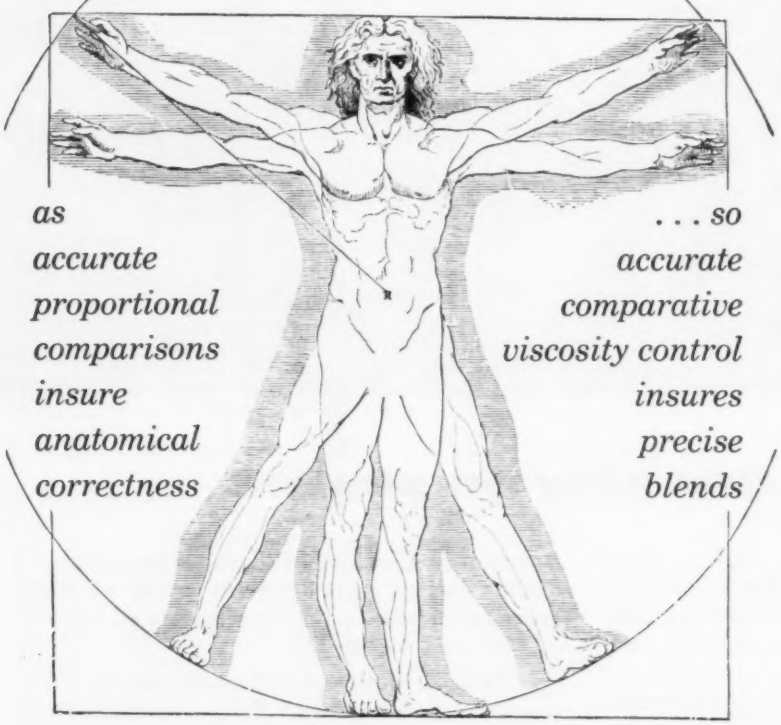

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. . . so accurate comparative viscosity control insures precise blends

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Accurate blending of petroleum products to a specification viscosity can be controlled continuously and automatically. The viscosity of the process fluid is compared with that of a reference sample at operating temperatures. Wide-range temperature compensation is inherent in the Bendix Viscomparator's design. Its sensing element withstands up to 650° F. (343° C.) and 1,000 psi.

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Canada: Computing Devices of Canada, Ltd., Box 508, Ottawa 4, Ontario

Building . . .

of the ethylene will be converted to ethylene oxide and glycol to meet developing needs on the East Coast. Further details will be announced later. Dry gas from Sun Oil Co.'s Marcus Hook, Pa., refinery will be used for the production of ethylene, as the SunOlin plant in Delaware is adjacent to Sun's unit. SunOlin's ethylene will complement Sun Oil's recently announced propylene production, thus providing "the only large source" for both (ethylene and propylene) on the East coast. SunOlin has begun engineering which will lead to negotiations with contractors for construction of the new unit. Last June, SunOlin announced start of construction on the $8-million urea plant at North Claymont. The plant will be completed early next year.

Iran is planning to construct a nitrogen-fertilizer production complex at Shiraz, to be operated by the French company ENSA. Société Belge de l'Azote et des Produits Chimiques du Marly (SBA) at Liège, Belgium, will design the nitric acid and ammonium nitrate producing plant, according to an agreement between it and the general contractor, ENSA. Foster Wheeler Francaise Co. will engineer the project.

Monsanto Chemical Co. will build a multi-million dollar plant in the six-nation European common market to manufacture polyvinyl butyral plastic sheet. The new plant is expected to be in production by late 1960 or early 1961. Plant-site studies are nearing completion, with the location of the unit to be announced later.

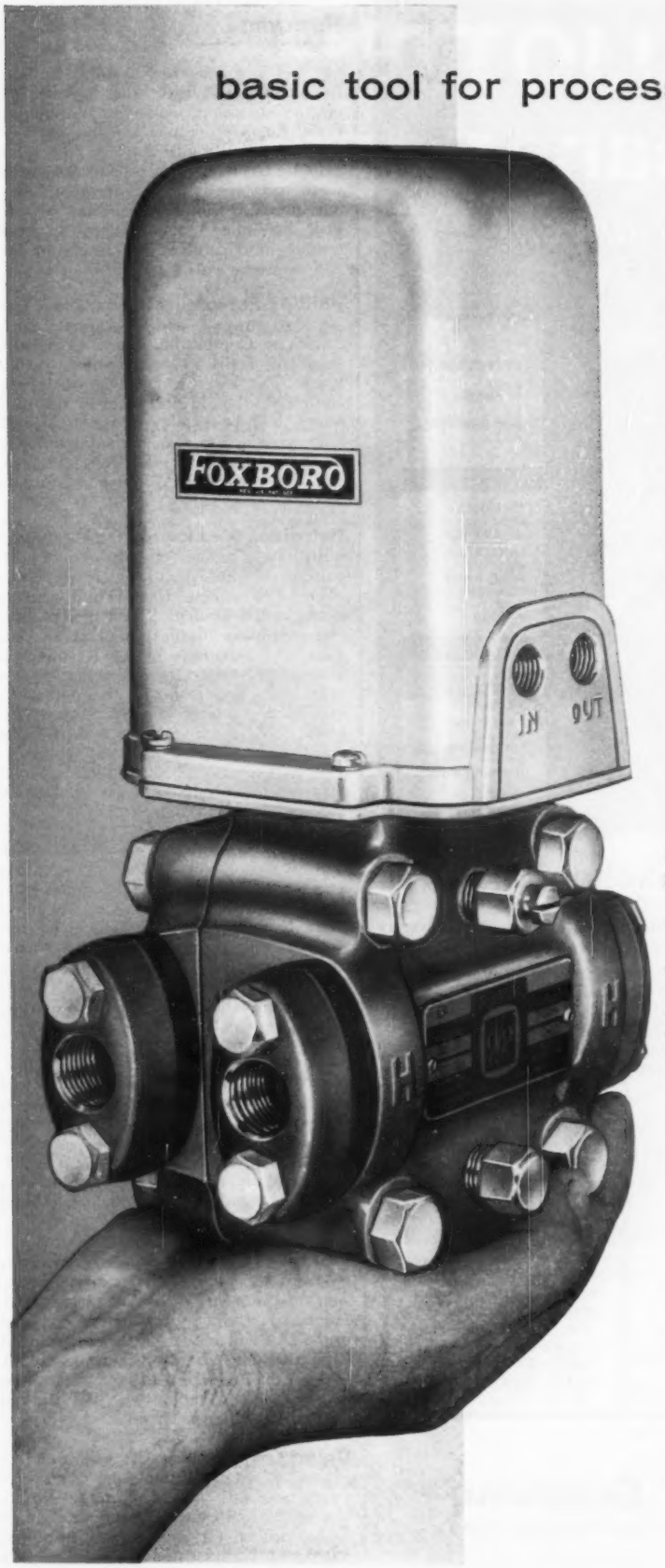
Texaco, Inc. has almost completed a second catalytic reforming unit at its Lawrenceville, Ill., plant. The unit consists of a 12,000-bpd hydrotreating section, 26,000-bpd feed-preparation section, and 12,000-bpd Platformer. Bechtel Corp. is the contractor. The company is also building a 12,000-bpd catalytic reformer and a 12,000-bpd hydrotreater at Wilmington, Calif. Both units are to be completed in June.

Innisfail Operators Committee plans to construct a new crude-oil processing, gas treating, and sulfur recovery plant in the Innisfail field, 50 miles north of Calgary, Alba. This plant will be built in addition to the one announced for that area three months ago. The new unit will process 10,000 bpd of crude oil, 8.7 MMcf of dry gas, 160 bpd of natural gas liquids, and 80 long tons of sulfur.

Hercules Powder Co. is planning a 100-million-pound-per-year polypropylene plant at Lake Charles, La. Construction will begin immediately, with completion of the first 50-million-pound-per-year unit slated for early 1961. Propylene will be supplied by Petroleum Chemicals, Inc. Hercules has one other polypropylene plant.

Union Oil Co. of Calif. has awarded The Fluor Corporation, Ltd., three separate contracts worth about $4-million to

basic tool for process measurements . . .



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D/p Cell bodies are available in 316 s.s. or rustproofed carbon steel. Unique stainless steel twin-diaphragm capsule is specifically designed to provide positive overrange protection. Purged cover protects transmitter from weather, dust, and fumes.

You can install d/p Cells anywhere — in any position — simply and conveniently, and know they'll give unequaled accuracy and performance. Ask your Foxboro Field Engineer for complete details, or write for Bulletin 13-11A. **The Foxboro Company,**
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Foxboro d/p Cells for flow, liquid level, and other variables

- for high-speed flow measurement and control
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Three fully adjustable ranges:
0-5 to 0-25 inches of water
0-20 to 0-250 inches of water
0-200 to 0-850 inches of water
Working pressures of 500, 1500, and 6000 psi

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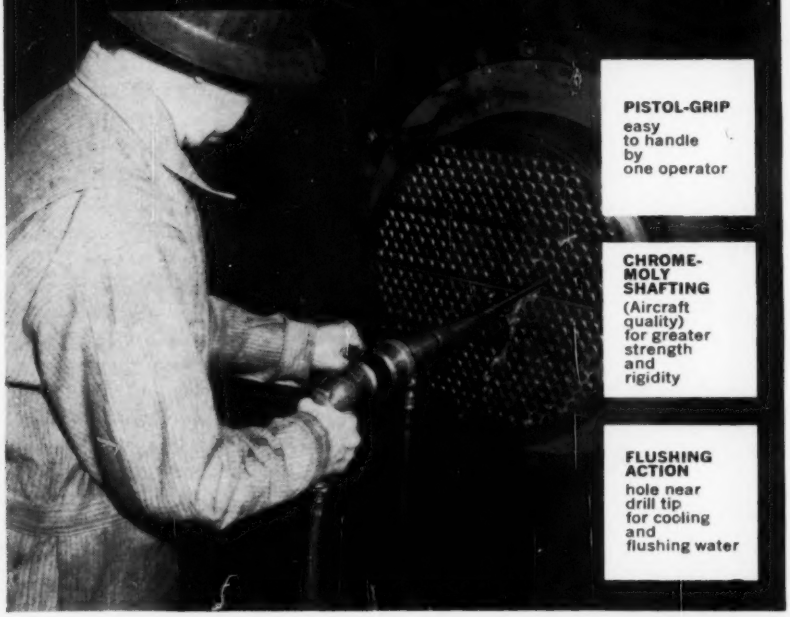
newest ELLIOTT tube cleaner

lightweight! air-driven!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easy to handle by one operator
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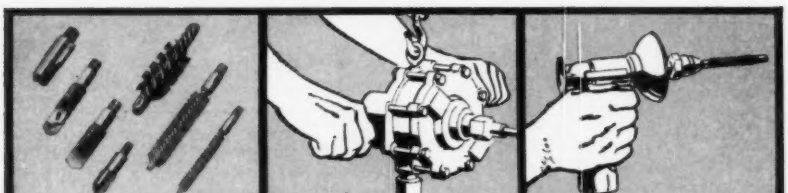
(Aircraft quality) for greater strength and rigidity
FLUSHING ACTION
hole near drill tip for cooling and flushing water

for condenser and heat exchanger tubes

Lightweight. Powerful. Air-driven. Trigger-action control with speed governor to prevent shaft-whip. High-speed motor reduced through planetary gears to 1500 rpm. Integral water-feeding attachment with finger-action valve which controls flow of cooling water into hollow shaft and drill or brush. Built-in oil reservoir. Send for tube cleaner bulletin Y-48.



DRILLS AND BRUSHES FOR VARIED NEEDS
Brushes for light deposits. Four types of drills clean light, hard-heavy, hard-light, and gummy deposits.

SUSPENSION TYPE
Air, steam or electric heavy-duty motor, for removing hard, heavy deposits. Ball bearings absorb thrust in either direction.

ELLIOTT JIFFY GUN
For extra-fast cleaning of light deposits in tubes ½ in. to 1¼ in. Air or water pressure shoots nylon brushes or rubber plugs through tubes.

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Y9-1

Building . . .

engineer and construct a carbon monoxide boiler, gasoline blending facilities and offsite expansion work at Wilmington, Calif. Engineering and procurement have begun in Fluor's Los Angeles office. The gasoline blender and offsite expansion work will be engineered at the refinery. The new CO boiler will substantially reduce atmospheric contaminants by incinerating fluid catalytic cracking unit flue gas to produce steam.

Phillips Petroleum Co. and the Italian company, Azienda Nazionale Idrogenazione Combustibili, plan to build a plant in Italy to manufacture carbon black. The two firms will form a new company to build and operate the unit, which will have a capacity of 25 million pounds per year. Scheduled to be in operation within two years, the plant will use the basic Phillips oil-furnace black process.

Petroleos Mexicanos has the following projects under construction: (1) expansion of the Atzcapotzalco alkylation plant, (2) a new 100,000-bpd refinery near Ciudad Madero, (3) a new refinery and expansion of the gas plant at Poza Rica, (4) expansion of the Reynosa gas absorption plant, (5) a new absorption plant at La Venta and El Plan fields, (6) expansion of the Ciudad Pemex gas plant, (7) expansion of the Minatitlan cracking facilities, (8) a new catalytic unit and a primary distillation unit for Salamanca refinery, and (9) a lube-oil terminal at Minatitlan.

Imperial Oil, Ltd. is installing a 1,500-bpd alkylation unit at Edmonton, Alba., at a cost of $2.4 million. Completion is scheduled for early this year. The company is adding a 2,800-bpd platinum-catalyst Powerformer at Regina. Canadian Kellog Co., Ltd., is handling construction. A 1,500-bpd alkylation unit is to be completed in February at Sarnia, Ont. Canadian Bechtel has the construction contract.

Irving Refining, Ltd. will complete a new 40,000-bpd refinery at St. John, N. B., this spring. It will include a two-stage crude unit, a 13,000-bpd fluid catalytic cracker with 30 percent recycle, a 7,150-bpd catalytic reformer, a 5,000-bpd hydrodesulfurization unit, and a 2,500-bpd hydrogen treating unit.

Kerr-McGee Oil Industries, Inc. is slated to complete its refinery expansion program at Wynwood, Okla., this month. The project includes upping crude-unit capacity to 25,000 bpd, and a $1.5-million catalytic cracker revamp. A new 10,625-bpd vacuum unit will also be installed. Construction will be handled by Kaighin-Hughes-Litwin.

Union Oil Co. of Calif. will complete expansion of its Wilmington, Calif., refinery next fall. Included in the project is a 14,000-bpd catalytic reformer, 17,400-bpd Unifiner for high-octane gasolines, 4,000-bpd Unifiner for upgrading heavy

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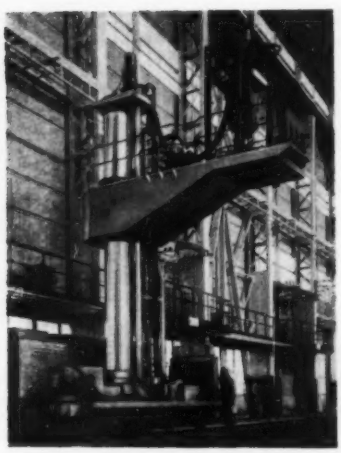
"WORLD WIDE" FABRICATOR OF PROCESS EQUIPMENT

CHIYODA CHEMICAL ENGINEERING & CONSTRUCTION CO., LTD., Japan's most experienced and leading fabricator of process equipment such as heat exchangers, coolers and condensers, has been serving the petroleum and chemical industries of the world for many years. Chiyoda has been receiving inquiries from American oil refining companies and contractors and has exported heat exchangers, vessels and towers to several major projects in construction. Repeat orders are being welcomed, which is evidence of Chiyoda's expert workmanship, early delivery and competitive prices.

At our Kawasaki factory, extra thick plates of large diameters and lengths for higher temperature and pressure services, are worked in accordance with ASME, ASTM or other standards.

Modern equipment and advanced techniques are combined to assure you the best in quality and precision . . . . right on schedule . . . . at costs which guarantee you the most for every dollar spent.



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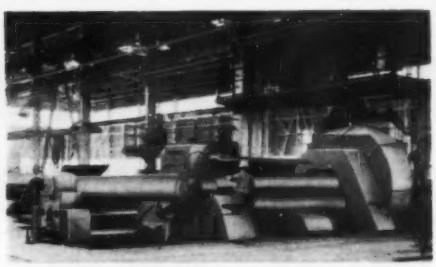
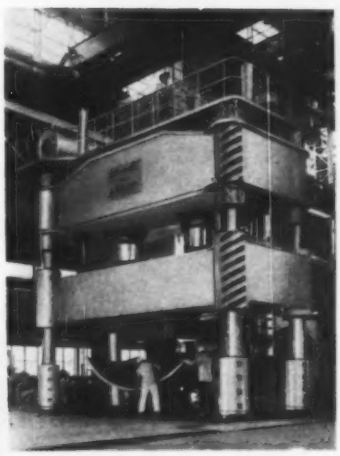


4 Rolls Bending Roller



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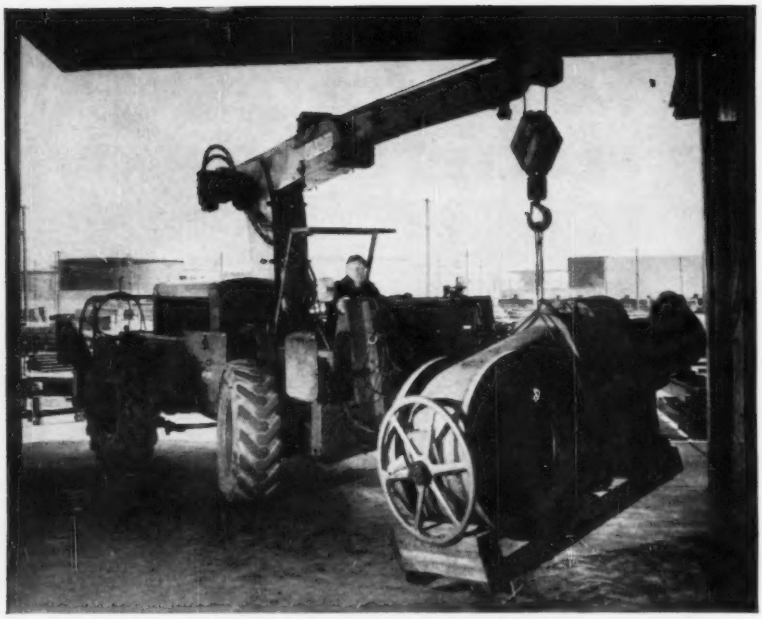


A-W crane carries 5000-lb. gate valve through low warehouse doorway. Crane requires minimum 10½-ft. overhead clearance.

Seven A-W cranes help Atlantic Refining reduce maintenance costs

"Since 1956, we have reduced the cost of crane maintenance by about 30% through the use of A-W equipment," says Walter O. Hoffman, general superintendent of Atlantic Refining Company's service division, Philadelphia, Pa.

Fast, highly maneuverable

As a result of a careful evaluation of crane performance in every maintenance operation, Atlantic Refining now has a fleet of six self-propelled, rubber-tired cranes and one truck-mounted unit.

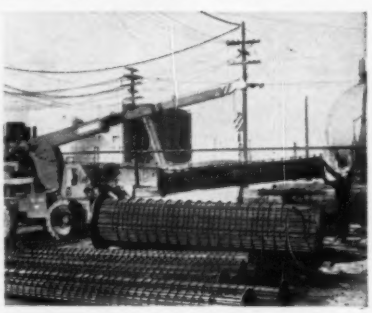
These highly maneuverable cranes, with all-wheel steering, work close to equipment, travel at traffic speeds, and pass under overhead obstructions as low as 10½ ft.

The A-W's handle 75% of all lifting jobs in the refinery. For instance, an A-W can lift out an exchanger bundle, carry it to the repair shop, position it for mechanics, and later reverse the process to speed installation of the repaired unit.

Mr. Hoffman adds, "The efficiency of our maintenance force depends greatly on the efficiency of the equipment it has to work with. The adoption and use of the Austin-Western hydraulic cranes is an example of our continuing effort to provide the most efficient equipment available!"

Reduce your costs

Learn how all-wheel drive and all-wheel steer A-W cranes can reduce maintenance and handling costs in your operation. Complete crane line now available—varying capacity ranges and boom lengths. Get all the facts today from your nearby Austin-Western distributor or write us direct.



Precision hydraulic control simplifies removal, handling, repair and maintenance of delicate heat exchanger bundles.

Austin 1859 AUSTIN-WESTERN 1959 100th YEAR PARTNERS IN PROGRESS Western

CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.

BALDWIN · LIMA · HAMILTON

Power graders • Motor sweepers • Road rollers • Hydraulic cranes

Building . . .

catalytic-cracked gasolines, and 10,000-bpd diesel-oil Unifiner. Also planned is a $1.5-million carbon monoxide boiler. C F Braun & Co. is the contractor.

American Chemical Corp. is build-new facilities at Long Beach, Calif., for production of ethyl chloride, ethylene dichloride, and vinyl chloride monomer. The unit is to be completed this month. An additional unit for vinyl chloride polymer is to be completed in April.

Sui Carbon Co., Ltd. has been formed by Continental Oil Co., Burmah Oil Co., and the Pakistan Government to build a 36-million-pound-per-year carbon black plant in Pakistan. The plant will process 70 MMcf of gas per day.

Petroleo Brazileiro plans to build a 40,000-ton-per-year synthetic rubber plant at its Duque de Caxias, Brazil, refinery, currently under construction near Rio de Janiero. A copolymerization unit using imported butadiene and styrene will be used, and Firestone and Goodyear rubber companies will provide technical and other aid. Another 40,000-ton-per-year plant is planned for Pernambuco State.

Anglo-Equadorian Oilfields, Ltd. has completed construction of a new distillation unit in Equador and a complete plant is scheduled to be on stream within four months. The $5.6-million investment is reportedly the largest made in Equador in recent years.

Wilshire Oil Co. is to complete construction of a new HF alkylation unit this spring at its Norwalk, Calif., refinery. In addition, the company plans to complete a 1,500-bpd alkylation unit at Santa Fe Springs, Calif., this spring. C F Braun is also handling both projects.

Continental Oil Co. is building a plant at Lake Charles, La., to manufacture petroleum-derived industrial alcohols formerly produced only from natural fats and oils. Capacity will be more than 50 million pounds per year of straight-chain primary alcohols, produced from ethylene raw material. Lummus Co. is to have the unit completed early in 1961.

Gulf Oil Corp. is constructing a new plant at Philadelphia for production of 35 to 40 million pounds per year of oxo alcohols. To be completed in December, the plant will later add facilities to produce oxo derivatives. The company also plans to up high-purity ethylene capacity by this summer.

Coastal Products Co. is building a 7,000-bpd delayed coking plant at Corpus Christi, Texas. Slated for completion early this year, the unit is being constructed by Treco Construction Division (former Refinery Engineering Co.) at a cost of about $3 million.

Lion Oil Co. is scheduled to complete its expansion at El Dorado, Ark., in April. Capacity of the vacuum unit,

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K&M ZEBRA

THE YEARS-AHEAD DEVELOPMENT IN PIPE INSULATION!

3 times faster to apply than 2-layer segmental insulation, new "K&M" ZEBRA is a multi-layer sectional-type thermal insulation for low, medium and high temperatures. And, it's as rugged as it is speedy. ZEBRA withstood repeated drops up to 8 inches without cracking...in increments of one inch. Bend it...and there's no cracking. (Its deflection at breaking point is 2 to 4 times that of ordinary insulation.) That's why breakage during installation practically disappears. There's a new ease of handling, too. No skin irritation. No skin penetration by ragged projections. "K&M" ZEBRA is smooth-surfaced. Get more information on this exciting, new development in pipe insulation. Write to us today for more information.

• For temperatures of 200°F. to 1200°F. • Withstands shock and heat without warping or cracking. • Made of calcium silicate—asbestos fiber bonded felts. • Can be re-used . . . can be dismantled and re-applied. • Available in wide range of sizes and thicknesses. • Tested by an independent testing laboratory.

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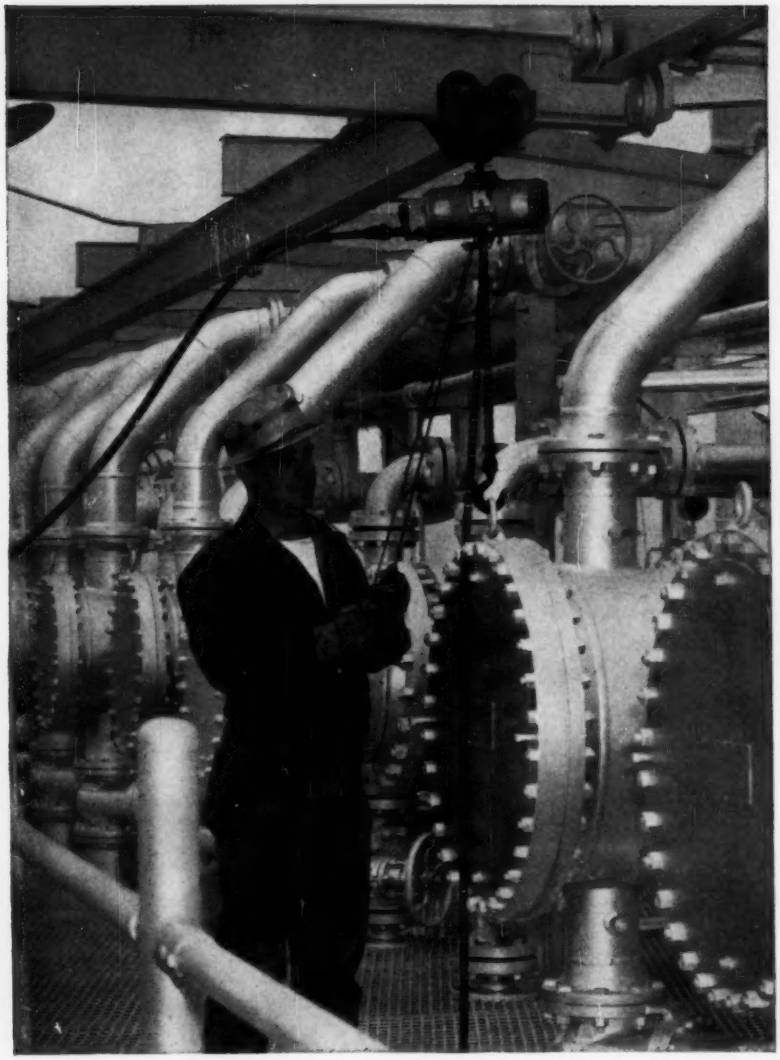

Fire-safe lift

with nonsparking air hoist

For the swift, safe lift that's free from fire and explosion hazards, use Gardner-Denver air hoists. Nonsparking axial-piston air motor makes these handy hoists ideal for jobs in chemical, gaseous or dusty atmospheres. In addition to their vital safety features, Gardner-Denver air hoists provide easily controlled speed for the quick, steady lift you need—with gentle starts and accurate stops. Capacities from 150 lb. to two tons. Write for Bulletin 80.

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Building . . .

which is charging topped crude, will be increased from 18,400 to 19,800 bpd. In another increase, the fluid catalytic cracking unit will go from 5,400 to 7,864 bpd with an 855-bpd recycle, Thermofor unit from 6,400 to 7,670 bpd, sulfuric acid alkylation unit from 1,200 to 1,800 bpd, catalytic polymerization unit from 350 to 600 bpd, and straight-run basic asphalt from 2,700 to 2,800 bpd.

New Island Refinery for Lago Oil & Transport Co.

An engineer inspects a model of Lago Oil & Transport Co.'s new refining unit being designed at the Esso Research and

Engineering Co. facilities, Florham Park, N.J. The unit will be built on the island of Aruba, off the South American coast.

Continental Oil Co. is adding an 11,000-bpd catalytic reforming unit at Lake Charles, La. The $3-million unit is being built by Bechtel Corp.

Cooperative Farm Chemicals Association is building new nitric acid facilities at Lawrence, Kan. The unit is to go on stream early in 1960.

Western Natural Gas Co. plans to carry out a 12,500-bpd refinery expansion at Brownsville, Texas. The project is expected to cost about $2.5 million.

British American Oil Co., Ltd. is expanding its catalytic reformer from 2,000 to 3,000 bpd at Calgary, Alba. Treco Construction Division (former Refinery Engineering Co.) is the general contractor. B-A is also adding a 3,000-bpd alkylation unit at Clarkson, Ont., to be completed this spring, and a 5,400-bpd catalytic reformer for Moose Jaw, Sask.

For more data on advertised products, use Readers' Service Cards, last page.

For 99 out of 100. . .

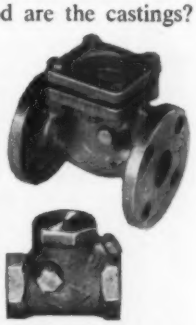
Selection of Stainless Steel Valves can be as simple as selection of Bronze and Iron valves

HOW to keep it simple? Don't let the wide selection of stainless steel alloys "throw you"!

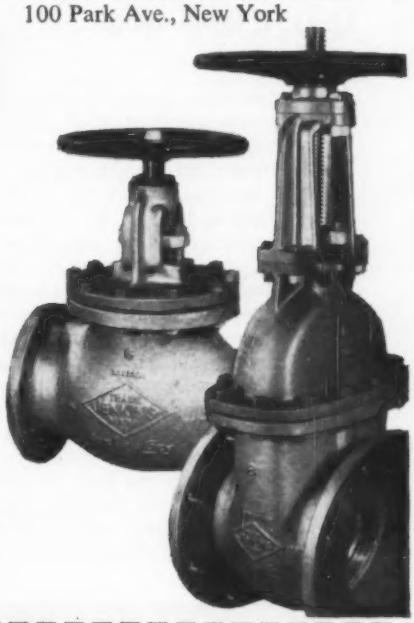
Most of the alloy specs were developed to meet certain highly specialized and rather uncommon needs. Only 1 out of 100 valve users can make practical use of many of the alloys. *Actually, just two or three of the different available alloys will give a big majority of valve users all they want and need.*

You can judge DESIGN differences between the various "makes" exactly as you do it with Bronze and Iron valves. Look them over and compare. Basically, of course, a Stainless Steel valve is designed and constructed very much like other valves.

What is left to worry about in addition to Material and Design? The same factors you consider in buying ANY valves for long, dependable performance: Are the valves made merely good enough, or to a standard that demands an extra-measure of quality? How good are the castings? How precise and perfect is the machining? How rigid is the inspection and testing during manufacture? These are the factors which specs can't cover. Some of them you can't see when you look at the valve. But you KNOW how to make sure they measure-up to peak standards. You know that the name JENKINS VALVES and the famous Jenkins DIAMOND trademark have been the highest assurance of quality for nearly a century.



Specify "*Jenkins*" as well as the metal alloy to assure fullest satisfaction. Your Jenkins Distributor has patterns and alloys to satisfy most industrial needs. Of course, they meet valve industry specifications and the high standards established by leading users of stainless steel valves. Jenkins Bros., 100 Park Ave., New York



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SARCO

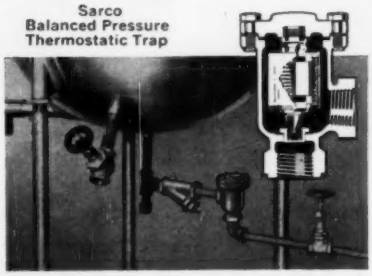
NOW... MATCH STEAM TRAPS

THERE'S no such thing as an all-purpose steam trap. That's why it pays to know what each trap has to offer. Here are five examples that demonstrate how you can match the correct steam trap type to the exact requirements of *each* application.

EXAMPLE 1: Outside Tracer Lines: A tough set of requirements

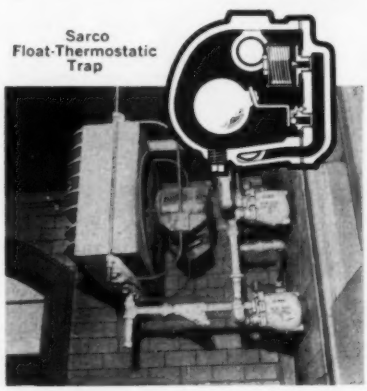
One of the most demanding sets of requirements a steam trap has to face is found in *outside steam tracing*. The trap must not only rid tracer lines of condensate and air immediately they're formed, but it must do so under exacting conditions. Pressures on each trap may vary widely. Installations may be remote and inaccessible to service. Water hammer may be a constant threat; freezing may be a hazard. Only the unique Thermo-Dynamic trap takes all these demands in stride. The Sarco TD-50 operates perfectly *without adjustment* through its full pressure range of 10-600 psi. It's virtually immune to water hammer and won't freeze when installed with a free discharge. Maintenance is, therefore, negligible. Compact, requiring no external support, the TD-50 is just about the easiest trap in the world to install. Once it's installed, you can forget it. You can count on an extremely long, trouble-free service life with minimum maintenance attention.

More closely than any other model, the TD-50 approximates an all-purpose trap. However, special application requirements might dictate the use of another type of Sarco trap. Sarco engineers stand ready to help you solve any trapping problems.



EXAMPLE 2: For steam jacketed process kettles: a trap that operates immediately on start-up and self adjusts to both low and high pressures

When a large steam-jacketed process kettle starts up, the condensate load is high, and all air in the jacket must be released quickly. At this stage, however, the jacket pressure is low; yet it builds up rapidly as the process continues. Because a SARCO No. 9 Balanced Pressure Thermostatic Trap is wide open on start-up, it releases initial air and condensate without the need for a bypass. And because it is self-adjusting, it works just as efficiently during the first processing stage when the jacket pressure is high. There are no seats to change for various working pressures. You can see why it is the obvious choice for steam jacketed process kettles.



EXAMPLE 3: How to prevent water-logging in unit heaters and blast coils

All unit heaters and blast coils have a relatively small internal volume in comparison with their steam condensing capacity. Even slight water-logging can reduce heat output seri-

Impartial advice on trapping because
ONLY SARCO MAKES ALL 5 STEAM TRAP TYPES

TOPICS

TO YOUR TRAPPING NEEDS

ously. Pressures may vary widely under automatic temperature control and so may the load because of variable demand. A trap to handle this application must adjust itself instantly to pressure and load charges. The most precise answer to this problem is the SARCO Float and Thermostatic Trap—and here's why: it releases air on start-up and during running, and, because it discharges condensate continuously, it does not set up in the system violent pressure changes that would upset close control.

Sarco Liquid Expansion Trap

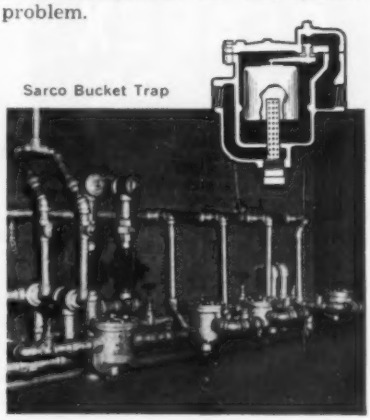
EXAMPLE 4: How to release low temperature condensate

When condensate cannot be returned to the boiler feed tank either because of distance or because it may be contaminated, it's economical to utilize some of the sensible heat as well as the latent heat of the steam.

For this purpose a trap must be capable of releasing condensate to temperatures as low as 100° F.

The sound trap selection here is the SARCO No. 871 Liquid Expansion Trap because it can be set to release condensate at temperatures down to 100° F. regardless of supply pressure. This performance assures maximum steam economy. The Sarco No. 871 handles the starting load easily because of its wide open valve, which throttles the flow as the condensate temperature rises. Furthermore waterhammer cannot reach the operating element. No other type is as nearly perfect for this specific problem.

Sarco Bucket Trap



EXAMPLE 5: Economic handling of Water Hammer and Corrosive Conditions

In applications in which water hammer or corrosive conditions are encountered but in which low pressures or extremely high back pressures preclude the use of the Thermo-Dynamic trap, the Sarco Inverted Bucket Trap is recommended. While the Sarco I. B. is not exactly a fuel miser, its relatively rugged construction will withstand considerable water hammer; and, when it is fitted with stainless steel internal parts, it offers excellent resistance to corrosion.

* * *

CONCLUSION: The right application is the economical installation

When you choose steam traps that serve their purpose without frequent adjustment, and without maintenance or replacement problems, you save on down-time, man-hours, spare parts, and production slowdowns.

You can get the money-saving solution to every trap selection problem by consulting Sarco. You get impartial solutions, because only Sarco makes all 5 types of steam traps: Thermo-Dynamic*, Thermostatic, Float Thermostatic, Liquid Expansion, and Bucket.

You also get the benefit of Sarco's 50 years of specialized experience in the manufacture and application of temperature regulators, industrial air vents, pipeline strainers, dial and industrial thermometers, heating and cooling controls, heat exchangers, heating control systems and heating specialties.

For literature or impartial help in solving your steam trapping or control problems, contact your local Sarco Sales Representative, or write direct to Sarco. 1440

*U.S. Pat. No. 2,817,353, T.M. Reg. U.S. Pat. Off.

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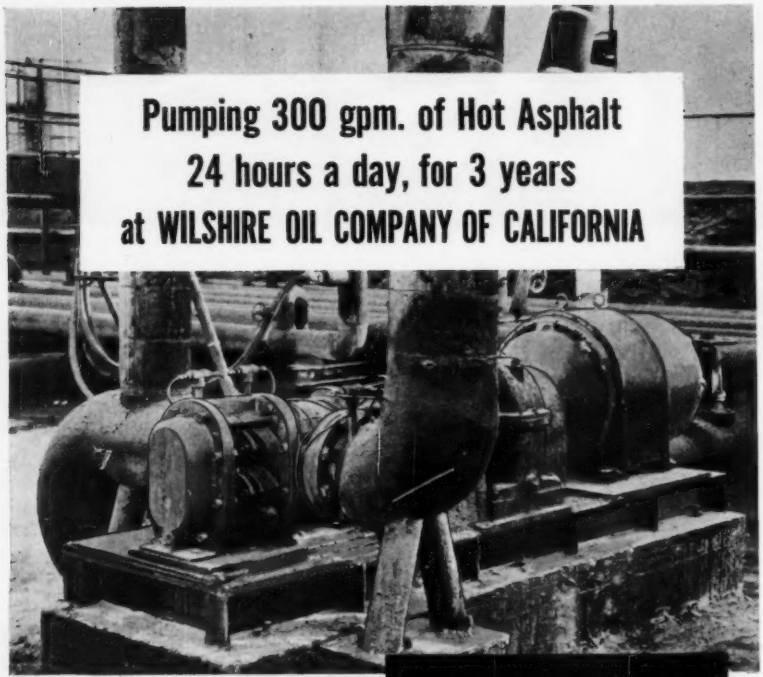

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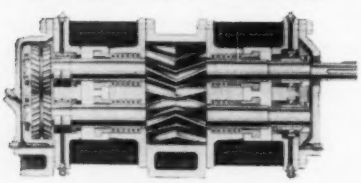
"No maintenance except packing", reports Wilshire

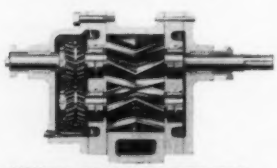
• This Gearex Pump continuously circulates asphalt at 250-450° F. from storage tank through heaters to truck loading rack and back to tank, operating with flooded suction at a discharge pressure of 100 psig. Asphalt is pumped a maximum distance of 800 feet.

Sier-Bath GEAREX® PUMPS

***Sier-Bath* "Gearex" Pumps**



EXTERNAL GEAR & BEARING TYPE
for non-lubricating liquids



INTERNAL GEAR & BEARING TYPE
for lubricating liquids

Sier-Bath "Gearex" Pumps provide positive displacement, pulseless flow . . . quiet, vibrationless operation. Direct-connected up to 1800 RPM, they require no reduction gears. For high volumetric efficiency and long life there is no rotor-to-rotor or rotor-to-casing contact. Low pressure on stuffing boxes provides easy servicing.

Horizontal or vertical models to handle 32 to 500,000 SSU, 1 to 550 GPM at 250 PSI for viscous liquids, 50 PSI for water. Corrosion-resistant alloys, steam-jacketed bodies, water-cooled bearings, other adaptations to meet individual needs. See "Yellow Pages" for your local Sier-Bath Pump Representative or send for Bulletin G-2. *Sier-Bath Gear & Pump Co., Inc., 9261 Hudson Blvd., North Bergen, N. J.*

Sier-Bath ROTARY PUMPS

Screw Pumps — Gearex® Pumps — Hydrex® Pumps

Founded 1905 — Mfrs. of Precision Gears, Rotary Pumps, Flexible Gear Couplings — Member A.G.M.A.

Building . . .

Jefferson Lake Petrochemicals of Canada, Ltd. plans to construct two new sulfur recovery plants, one just east of Calgary and the other in the Savanna Creek area. The Calgary unit is to be on stream by November.

Polymer Corp., Ltd. is planning a $15-million butadiene plant at Red Deer, Alba. The unit will have a capacity of between 25,000 and 30,000 tons per year.

American Gilsonite Co. plans to expand its Grand Junction, Colo., coking unit from 700 tons per day to 1,100 tons.

Atlantic Refining Co. is planning a 2,000-bpd capacity increase for its Philadelphia refinery. Completion of the revamp is slated for this month.

Century Refining Co. is adding to its Shallow Water, Kan., refinery a 1,000-bpd alkylation unit, a 3,000-bpd catalytic cracking unit, and gas recovery and stabilization facilities. Litwin Engineering Co. is to complete construction in mid-1960.

Mobil Oil Co. is increasing fresh-feed capacity of its Beaumont, Texas, catalytic reformer from 24,000 to 44,000 bpd. Contractor for the project is The Fluor Corp., Ltd.

Richfield Oil Corp. is planning to build a $50-million refinery at Everett, Wash. The unit is to be completed in 1965.

Shamrock Oil & Gas Corp.'s Sunray, Texas, refinery is scheduled to complete an 8,000-bpd fresh-feed Thermofor catalytic cracking unit this spring. The Fluor Corp., Ltd., is the general contractor.

Shell Oil Co. of Canada, Ltd. is planning a 20,000-bpd refinery at Bronte, Ont., near Toronto.

Standard Oil Co. (Indiana) will increase capacity of its 70,000-bpd fluid catalytic cracker at Whiting, Ind., by 10,000 bpd. The expansion is to be completed this year.

Texaco Canada, Ltd. is building a vacuum flashing unit to produce feed stock for a catalytic cracking unit as well as bunker fuel oil, at Montreal East, Que. The company is also adding a $1.8-million, 2,200-bpd alkylation unit.

Howell Refining Co. plans to up capacity of its Corpus Christi, Texas, refinery from 5,000 to 6,500 bpd. Completion of the project is scheduled for this month.

Standard Oil Co. of Calif. will complete its Honolulu, Hawaii, refinery next fall. The 25,000-bpd, $40-million plant, is being built by Bechtel Corp. The com-

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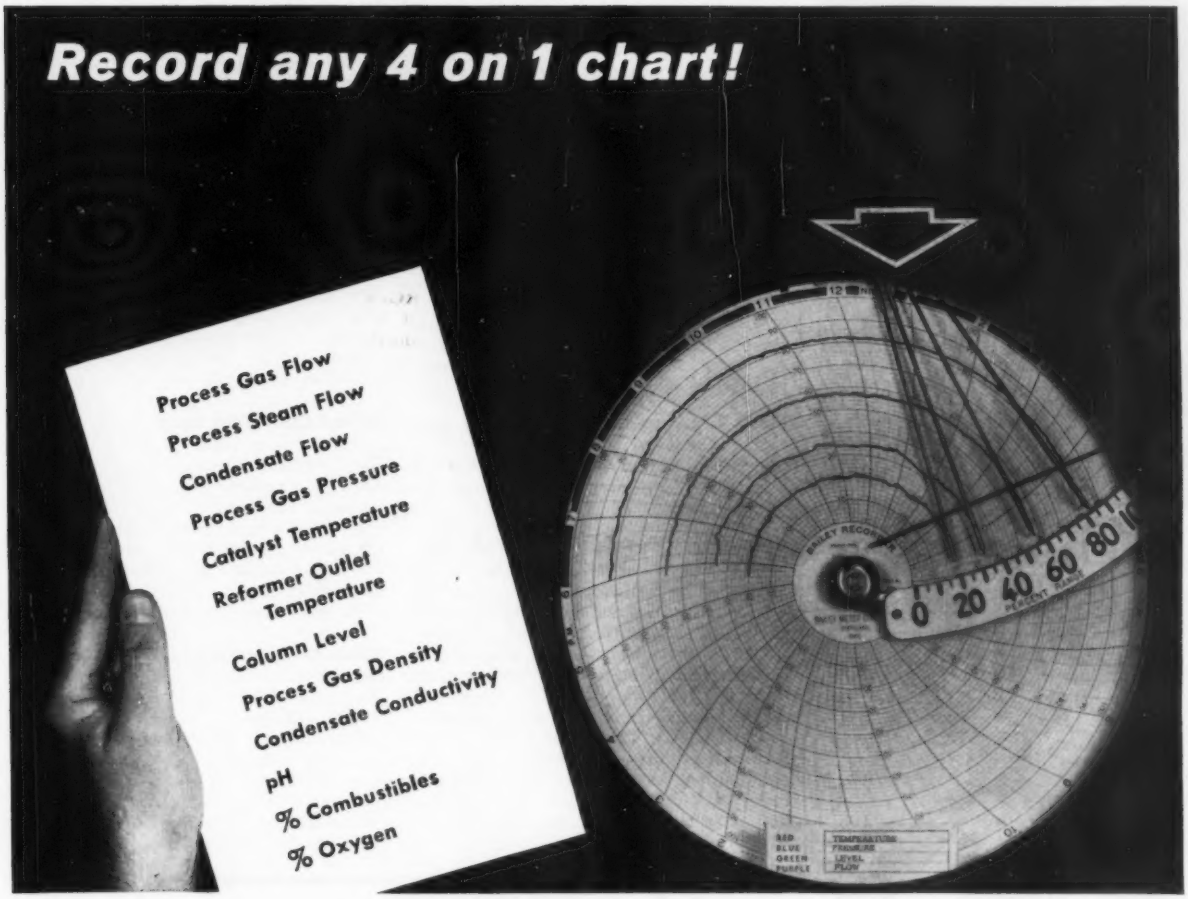

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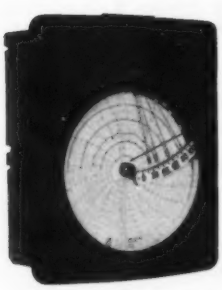
The BAILEY Receiver Recorder-Controller!



Records four variables on one chart.

You can lower the cost of your equipment investment and increase the efficiency of your entire operation with the Bailey Receiver Recorder.

HERE'S HOW

The interchangeable components for the Recorder make it fast, inexpensive, and automatic to do up to *four* measuring jobs at the same time with either or both pneumatic and electric systems.

This Bailey unit continuously and simultaneously records four variables on the same chart. And, they are *in the same linear scale measurement.* You have clear, easy-to-read records for continual analysis and control.

Plug-in, pre-calibrated receivers can easily be adapted on-the-job to revised process requirements. The Bailey Receiver Recorder saves you money with a minimum instrument investment for process cycle expansion or alteration. Let your local Bailey engineer suggest applications to fit your operation. Or write for specific control systems information for your entire plant operation.

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Chemical and petroleum division

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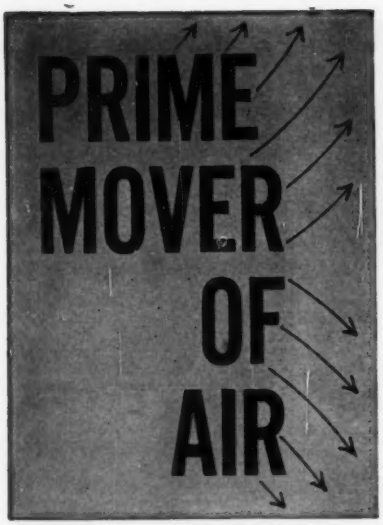

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KOPPERS Aeromaster Fans

Engineered Products Sold with *Service*

Building . . .

pany is also building a $75-million, 60,000-bpd plant near Everett, Wash., and a polymer unit at Richmond, Calif.

Farmers Union Central Exchange, Inc. is building a 7,100-bpd Unifiner at Laurel, Mont. The unit, which will use gasoline distillate feed, is slated for completion in May.

Gulf Oil Corp. plans to construct a refinery at Charleston, S.C. The company is also building an 11,000-bpd distillate treater at Cincinnati. Arthur G. McKee & Co. is to have the latter unit completed this year.

Hess Trading & Transport, Inc. plans to expand its Sewaren, N.J., refinery from 45,000 to 75,000 bpd. A Udex unit and fluid catalytic cracking unit are also planned.

Imperial Chemical Industries, Ltd.'s acrylonitrile plant at Cassel Works, Billingham, has been completed. The plant was announced in February 1959. British manufacturers of synthetic-rubber copolymers and acrylic textile fibres have previously been dependent on imported raw materials. The plant has adequate capacity to meet all foreseeable home demands. The major outlet will be for acrylic fibres, but there is an expanding demand for high-impact strength resins. ICI will itself use some of the output for its line of butadiene-acrylonitrile synthetic rubbers.

Phillips Chemical Co. plans to expand its Borger, Texas, synthetic rubber plant to a commercial scale. Output of the company's line of rubber, currently being produced on a pilot-plant scale, will be stepped up to 20,000 long tons per year with an expansion scheduled to be completed by August 1960.

Reichold Chemicals, Inc. will spend approximately $2.5 million to enlarge its Tuscaloosa, Ala., phenol plant. The enlarged facility, which is under construction, will increase RCI's phenol production from its current 60 million pounds. Sodium sulfite production will increase correspondingly for use by the paper industry in the South.

Allied Chemical Corp. has begun construction of a plant at Orange, Texas, for the manufacture of polyethylene glycols. The company plans to offer from its stocks at Orange, Texas, or from conveniently located stock points throughout the country, polyethylene glycol in varied molecular weights in tankcar and drum quantities; and in combination shipments with other glycols and/or ethanolamines.

Standard Vacuum Oil Co. is one of four international oil companies (two of them representing American capital) which will join in constructing a $35-million refinery in Pakistan. Preliminary work on design and engineering details is already under way. Actual construction will start about mid-1960 at Korangi, six miles east of Karachi, West Pakistan's main seaport on the Indian Ocean. The

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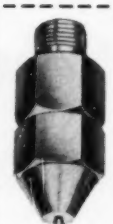
Flat Spray



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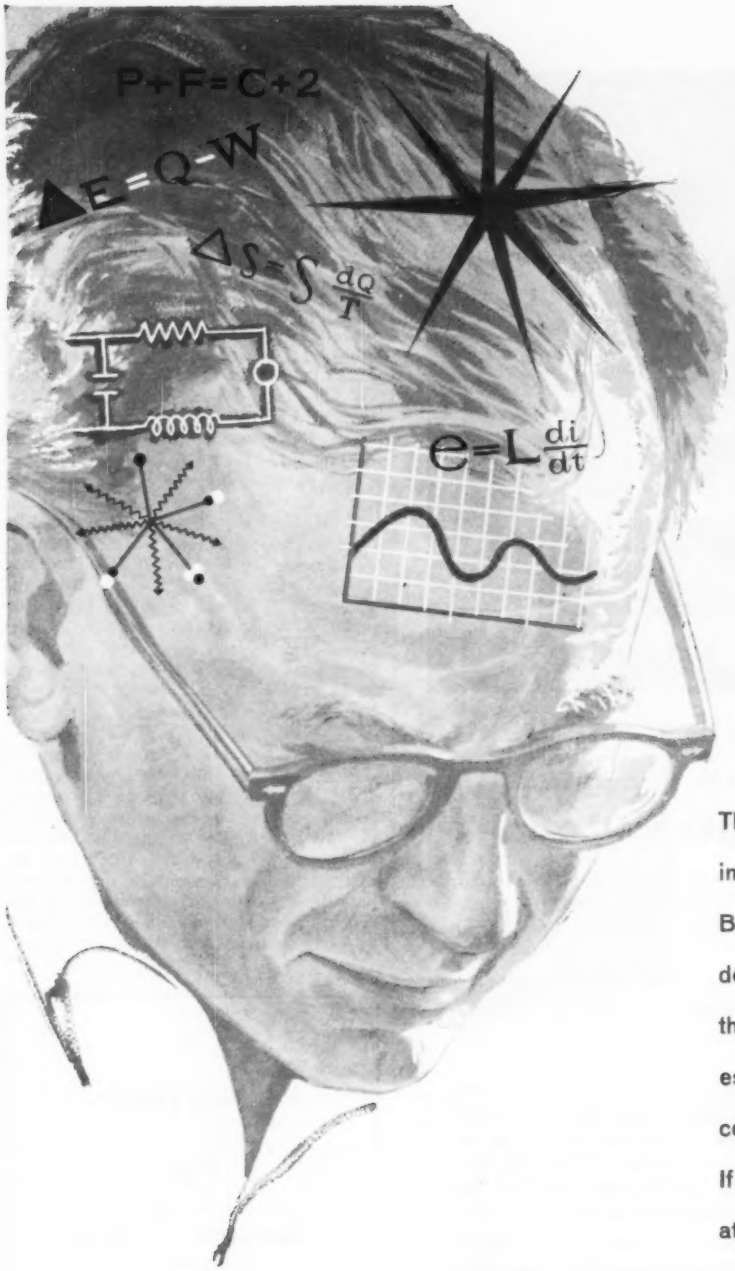

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The engineer has his specialized instruments, as does the surgeon. But the work these instruments perform depends upon the thought that guides them. Knowledge and judgment are essential to any project, but superiority comes only from originality... ideas. If there is a new and better way, engineers at Brown & Root will find it. Practical results in greater efficiency at lower costs have built a world-wide reputation for engineering by Brown & Root.

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Choose R-P&C cast steel valves in 7 pressure classes (150 lb. through 2500 lb.) for dependable strength and quality

• R-P&C Cast Steel Valves—with primary ratings of 150 lbs., 300 lbs., and up to 2500 lbs.—are ideally suited to the high-pressure, high-temperature demands of the petroleum industry and of steam power plants. Here are some of the reasons:

STRENGTH • The design of R-P&C Cast Steel Valves embraces ample metal walls which exceed Code specifications. All components are designed and built to assure that valves conform to A.S.A. and A.P.I. requirements.

QUALITY • Castings for Steel Valves are made in R-P&C's own foundry. They are produced under direct supervision and control of R-P&C technical personnel. These castings are subject to critical inspection. R-P&C's inspection facilities embody latest methods of non-destructive testing—including a 2-million volt X-Ray machine for the internal examination of High Pressure valve castings.

DEPENDABILITY • R-P&C Valves are carefully assembled to assure proper fit of all parts and good mechanical operation. They are individually tested to fully conform to specifications or Codes as required. No valves are released from production until they have completely and satisfactorily met inspection and test requirements.

SEND FOR FREE WALL CHART

"How to Protect Your Valves"

This 22" x 17" chart gives valuable installation pointers, operating tips, clues to longer service life. For free copy, write us at Reading, Pa.

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ACCO

R-P&C Valve Division, American Chain & Cable Company, Inc.

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

Building . . .

agreement with the Government of Pakistan was signed at Rawalpindi last November. The new plant will have an initial capacity of 32,000 bpd, substantially increasing petroleum refining capacity of the country which for many years has been limited to a small refinery at Rawalpindi. The new refinery will be large enough to take care of West Pakistan's anticipated requirements in 1962, the target year for completion. Design incorporates the possibility of expansion to 42,500 bpd. The other three companies are California Texas Corp. (Caltex), Shell Petroleum Co., Ltd., and Burmah Oil Co., Ltd. Together they will own 60 percent of the new refinery while the other 40 percent will represent private capital supplied from Pakistani sources. Principal processing facilities will be a crude distillation unit, a hydro treater and a catalytic reformer. The off-site facilities will comprise steam generating equipment, storage tanks, an office and shop buildings. Main products from the refinery will be motor gasoline, aviation turbo-fuel, illuminating kerosine, diesel fuel and industrial fuel oils. Foreign exchange savings for Pakistan are estimated at $7 million annually when the refinery is on stream.

Celanese Plastics Co. is expanding the capacity of its high-density polyethylene plant at Houston to 50 million pounds a year. The expansion is expected to be completed by March. The Houston plant, opened in March 1957, was the first to produce commercial quantities of high-density or linear polyethylene in this country. The Houston plant was designed to have a capacity of 40 million pounds

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They don't cost,

they pay.

For more data on advertised products, use Readers' Service Cards, last page.

Taylor ANNOUNCES THE TRANSCOPE* INDICATOR

Where recording function is not required, the 90K Indicator incorporates all other features of famed 90J Recorder.

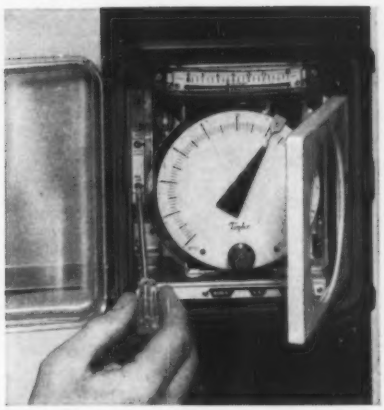
The new 90K Series pneumatic Dial Indicator brings you TRANSCOPE efficiency . . . with the initial economy of process variable indication only. It can be quickly interchanged with the TRANSCOPE Recorder, thanks to plug-in connections. 90K features include:

- Color-coded target-type pointers against full 10″ scale—for exceptionally easy reading.
- Powerful "Servomatic" powered pointers—assure precisely accurate pointer positioning.
- Front-of-panel control response settings give results at a glance.
- Same standardized components as in the 90J Recorder—minimum parts inventory necessary.
- In a control station, continuous indication of set, process and valve pressure.

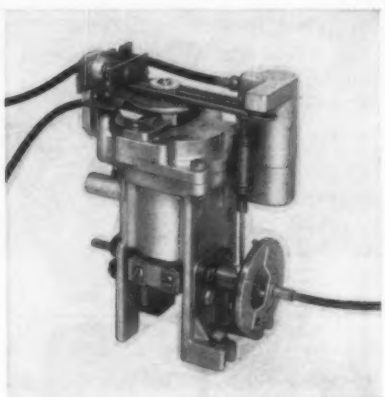
Optional features include: indication of a second variable on a separate dial; Cascade switch for pneumatic set control; electric or pneumatic process alarms.

For full details, call your Taylor Field Engineer, or write for **Catalog 98347.** Taylor Instrument Companies, Rochester 1, New York, or Toronto, Ontario.

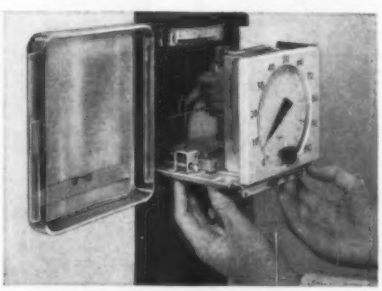
*Reg. U.S. Pat. Off.



Front of Panel Adjustments. Gain, Reset and Pre-Act* response adjustments can be changed where you see the results while making the change.



Servo-operated Pointers are positioned with 150 times greater power than with conventional bellows, which also permits one or two high-low process alarms—electric or pneumatic.



PLUG-IN Connections. The main slide, including indicator and set point transmitting mechanism, is removed by loosening one holding screw.

Taylor Instruments **MEAN ACCURACY FIRST**

For more data on advertised products, use Readers' Service Cards, last page.

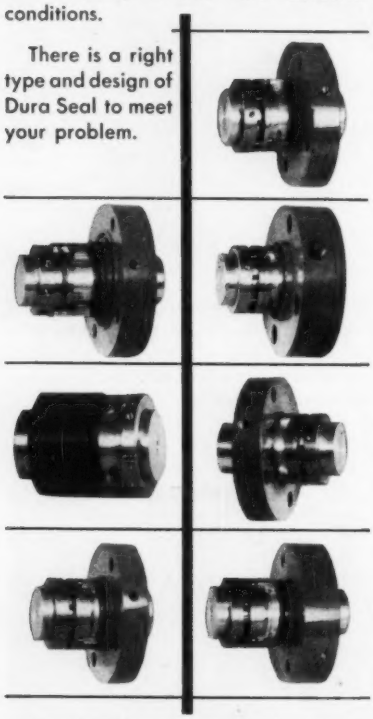
DURA SEAL

means VERSATILITY *in mechanical sealing*

Dura Seal is the most extensive line of mechanical seals offered to industry today . . . meeting a wider range of pressures, temperatures and liquids.

Dura Seal is backed by 25 years of experience in the successful sealing of corrosive, volatile and abrasive conditions.

There is a right type and design of Dura Seal to meet your problem.



For further details, write for free copy of Catalog No. 480 PR

The PERFECT SEAL TRADE MARK

DURAMETALLIC CORPORATION
KALAMAZOO, MICHIGAN

Building . . .

a year to be reached in stages. The current expansion, combined with more efficient utilization of facilities accounts for the 50 million pound figure. The company says that this is the "first major expansion for the production of linear polyethylene to be announced by an American producer."

Arkansas Louisianan Chemical Corp. plans to manufacture hydrochloric acid at its Pine Bluff, Ark., facilities. The material is being produced from by-products of other materials turned out in the facilities leased from the government at Pine Bluff Arsenal. Equipment to produce the acid was added during the fall at a cost of $50,000, giving the company a capacity of 6,000 tons of hydrochloric acid annually. The chemical company took over surplus segments of the Pine Bluff Arsenal in July 1958, and went into production of chlorine and caustic in October 1958.

Ethyl Corp. has increased its commercial capacity for making aluminum alkyls and alkyl aluminum halides, with a new plant recently completed and in operation. The plant, located in Orangeburg, S. C., is said to be the "first major plant to be completed in the United States for the production of aluminum alkyls." In operation since October, the plant utilizes several methods for producing these compounds, including a triethyl aluminum process developed by Ethyl. Completion of the new plant, which has a multi-million-pound capacity per year, gives Ethyl a complete line of aluminum alkyls and alkyl aluminum halides. These include triethyl aluminum, a mixture of triethyl aluminum and diethyl aluminum hydride, triisobutyl aluminum, trimethyl aluminum, diethyl aluminum chloride, ethyl aluminum dichloride, ethyl aluminum sesquichloride, methyl aluminum sesquichloride, and methyl aluminum sesquibromide.

Goodrich-Gulf Chemicals, Inc. will build a new plant for the production of oriented polyolefins in Port Neches, Texas. Adjacent to the company's synthetic rubber facilities at Port Neches, the new plant will at first produce a type of high-density polyethylene not currently manufactured in the United States. Construction of the plant, which will have an initial capacity of 13 million pounds annually, will be started immediately and is scheduled for completion late in 1960. Complete development laboratory facilities will be provided in the new plant. Engineering and construction will be handled by Ralph M. Parsons Co., Inc. Specific characteristics, including outstanding environment stress crack and thermal resistance, have been built into the Goodrich-Gulf polyethylene which will be manufactured by a new process based on Ziegler chemistry. This process has been developed during four years of pilot plant operation and is designed to produce ethylene polymers for use in bottle, pipe, wire and cable applications.

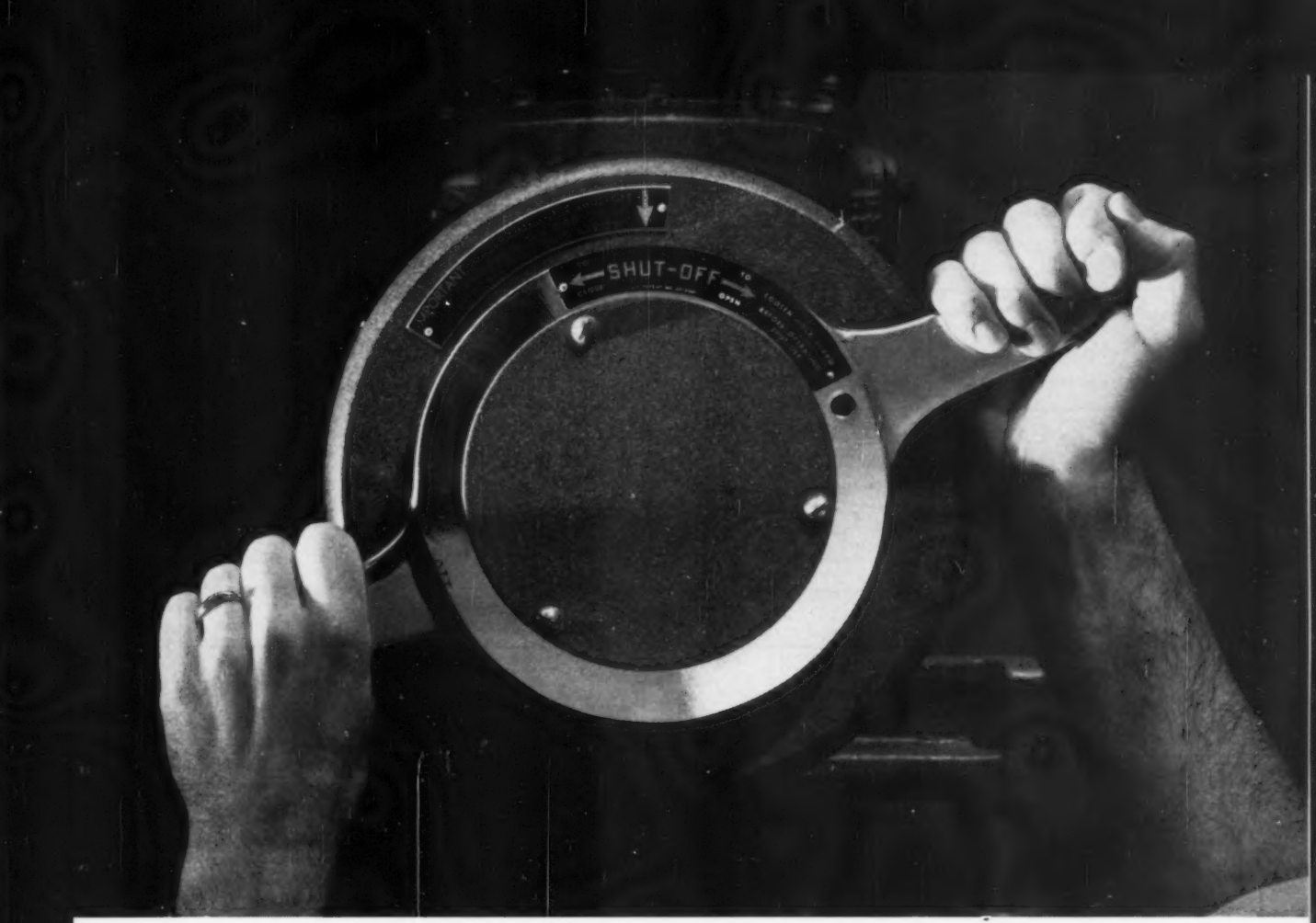
British Petroleum Co. has started installing equipment at its refinery on the Isle of Grain, England, for the production of special solvents used in the manufacture of paint and lacquers, and also in the essential oils, fatty oils and rubber industries. This will be the first installation constructed by BP in the United Kingdom for manufacturing these special boiling point solvents. The plant will have a capacity of 30,000 tons a year. Installations consist of an acid washery and redistillation unit, as well as associated tankage, lines, pumps and loading facilities for road and rail transport. The plant, designed by BP, is scheduled for completion in 1960.

Continental Oil Co. plans to construct a petrochemical plant at Ponca City, Okla., which will have a capacity of more than 20 million gallons of cyclohexane annually. The installation will cost more than $1 million. Procon, Inc., will construct the plant. Work will start immediately, with completion scheduled for September 1960. The petrochemical plant will be constructed on the present Conoco refinery property in Ponca City. Hydrogen from the refinery's catalytic reformers will be used to convert benzene into cyclohexane. With completion of the plant, Conoco will become the first producer of cyclohexane in Oklahoma and the fourth industrial firm in the nation to enter this market.

Administracion Nacional de Combustibles, Alcohol y Portland has awarded The Babcock & Wilcox Co. a contract to design and manufacture what will be the "first shop-assembled carbon monoxide (CO) fired boiler in the world." Scheduled for completion in 1960, the unit, which also will be the first CO-boiler in the southern hemisphere, will be part of a refinery extension in Montevideo, Uruguay.

British Petroleum Co. has opened a new laboratory at its Llandarcy refinery, South Wales. It has facilities both for routine product testing and for investigating problems associated with refining processes. Costing about $1 million to build and equip, the laboratory has a staff of 120. In addition to laboratories, the building includes offices, a conference room, library, sample store, engine test house, workshop and a reference fuels room.

Now turn to page 228 and read Construction Box Score, the most comprehensive guide to building in the Industry



How to repack a big-tank mixer – the easy way

Just a few turns of the handles.

That's all it takes to lock up 80,000 barrels of product in the tank, while your maintenance man renews the packing or replaces the shaft seal on this LIGHTNIN Side Entering Mixer.

No need to find another place to put a tankful of liquid in a hurry. No big wrenches. No sweat or strain.

When the job's done, a few turns put the mixer shaft back in operating position again, ready for business—*automatically* realigned.

It's *easy*—and it saves money.

You'll see these handles in refineries and at pipeline terminals all over the country. They're visible proof of the long-term savings refinery men look for, and find, in this side-entering mixer.

Just as important are some of the economies that *don't* show on the outside.

The wide choice of stuffing boxes, for instance: there's one to meet every mixing or blending condition.

The rotary mechanical seal that takes the place of a stuffing box, if you wish. It eliminates all repacking, positively stops leakage—and is *easy to replace* when it finally wears out.

There are many other savings you'll want to know about before you decide on mixers for *your* big tanks. Your LIGHTNIN Mixer representative can tell you what they are. You'll find his name listed in Refinery Catalog. Why not get in touch with him now?

BLENDING PRODUCT or controlling BS&W in crude—you get the job done faster, at lower cost with LIGHTNIN Mixers. They're used in tanks as big as 200,000 barrels. Results are guaranteed.

"Lightnin" Mixers

MIXCO fluid mixing specialists

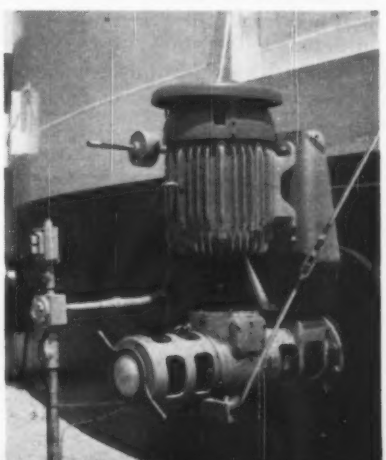
WHAT MIXING OPERATIONS ARE IMPORTANT TO YOU? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

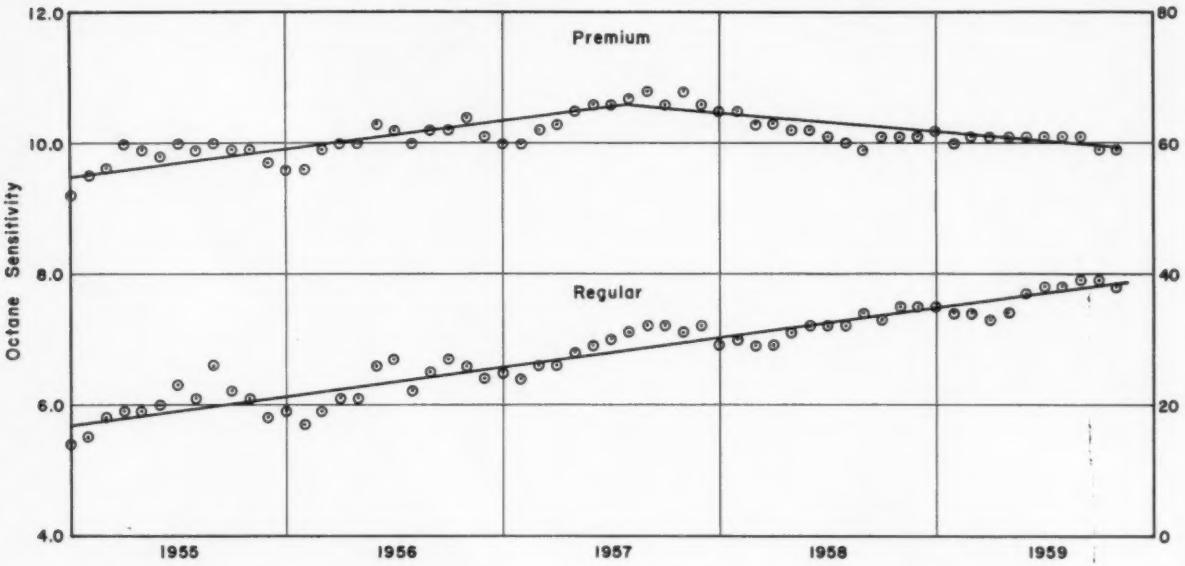
- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals (B-111)
- ☐ Data sheet for figuring mixer requirements (B-107)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 164-a Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.





"Construction Boxscore" data reveal . . .

Octanes Reflect Alkylation Increase

The rash of construction for alkylation units shows its influence on the octane quality of motor fuels on the market today. The spread between research and motor octane ratings for premium grade motor fuels is decreasing as more alkylate finds its way into these blends.

Octane sensitivity is the term given the difference between the research-octane rating of a motor fuel and its motor-octane rating. From data given in Ethyl Corp.'s monthly gasoline quality survey, the average octane sensitivity was obtained for premium and regular grades of motor fuels marketed in the United States for the past five years. These data are plotted in Figure 1.

Although each monthly average octane sensitivity is shown in Figure 1, straight lines are drawn to give an indication of existing trends. These trend lines show that the sensitivity of premium-grade motor fuels started to decrease shortly after the middle of 1957.

No clue to the decrease in octane sensitivity is given by observing the actual research-octane numbers of these premium-grade motor fuels. Throughout the five-year period, the research octanes continued to climb.

The answer to the reversal of octane sensitivity comes from an examination of the unusual growth of alkylation capacity and alkylate's exceptional octane properties. A review of PETROLEUM REFINER's quarterly "Construction Boxscore" shows just how much alkylation capacity has grown, and other PETROLEUM REFINER articles give information to compare the octanes of alkylate with other motor-fuel blending components.

Alkylation capacity in the United States has outstripped many other refining processes. The completion of alkylation units plus some increases in capacity of existing units are shown in Table 1. The table includes information on the crude running capacity of U.S. refineries for comparative purposes.

Notice how the capacity of available alkylation is growing to be a larger portion of refinery crude handling capacity. Thus, the motor-fuel production of these refineries can contain greater portions of alkylate.

The push for octanes is a big reason for the rapid acceptance of alkylation. The process is second only to reforming as a means of getting economical octanes. Alkylation has the advantage, too, of giving high motor-octane ratings as well as high research octanes. A comparison of alkylate with reformate is shown in Table 2.

TABLE 1—DAILY CAPACITIES FOR U.S.

First of Year	CRUDE (Thousand bpsd)	ALKYLATION (Thousand bpsd)	ALKYLATION (Percent of Crude)
1957	9,300	280	3.0
1958	9,600	308	3.2
1959	9,900	359	3.6
1960 (est.)	10,300	389	3.8

Automotive engine studies point out that motor octanes can be just as important as research octanes if a motor fuel is to satisfy modern high-compression engines. So expect alkylation to come on strong for several years yet. And look to the "Construction Boxscore," which follows, to see where new units are being built.

TABLE 2—OCTANES OF MOTOR FUEL COMPONENTS

Material	OCTANE NUMBERS		Octane Sensitivity
	Research	Motor	
Reformate @ 3cc TEL[1]	106	95	11
Alkylate @ 3cc TEL[2]	106	106	0
Premium Grade Avg.[3]	99	89	10
Regular Grade Avg.[3]	92	84	8

[1] Holt,P.H., II and Haig, R. R., "Data on Latest Reforming Process", PETROLEUM REFINER, 36, No. 9, 221 (Sept., 1957).
[2] Payne, R.E., "Alkylation—What You Should Know," PETROLEUM REFINER, 37, No. 9, 316 (Sept., 1958).
[3] Ethyl Corporation, "Gasoline Quality Survey" (Note: Ratings rounded to whole numbers).

Construction Boxscore

Oil, Gas and Petrochemical Processing Plants

East

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Allied Chemical	Buffalo, N.Y.	Polyethylene Pipe Compound	.....	.....	Complete	.....	.....	.....	.....
	Moundsville, W. Va.	*Fumaric Acid	.....	.....	Under Constr	Mid-1960	.....	.....	.....
American Cyanamid	Bridgeville, Pa.	Maleic Anhydride	20,000,000 lbs/yr	.....	Under Constr	Mid 1960	S D	S D	S D
		Phthalic Anhydride	40,000,000 lbs/yr	.....	Complete	.....	.....	.....	Foster Wheeler
	Bound Brook, N.J.	Phthalic Anhydride	7,000,000 lbs/yr	.....	Under Constr	Spring 1960	.....	.....	Foster Wheeler
Ashland O&R	Buffalo, N.Y.	*Naphthalene	50,000,000 gal/yr	.....	.....	.....	UOP	.....	.....
		*Synthetic Benzene	12,000,000 gal/yr	.....	.....	.....	UOP	.....	.....
Atlantic Refining	Philadelphia	Crude Revamp	2,000 bbls	$2,180,000	Under Constr	1960	.....	Staff	.....
Cary Chemicals	Flemington, N.J.	Polyvinyl Chloride, Polymers	.....	.....	Under Constr	1960	SD	SD	SD
Dow Chemical	Allyn's Point, Conn.	*Styrene-Butadiene Latexes	.....	.....	Engineering	Early 1961	.....	.....	.....
Du Pont	Belle, W. Va.	Urea, Ammonia, Methyl Methacrylate, Nylon Intermediates	.....	.....	Planned	1961	Texaco	.....	.....
	Florence, S.C.	Polyester	.....	$20,000,000	Under Constr	1961	.....	.....	.....
	Memphis, Tenn.	*Acrylonitrile	.....	.....	Under Constr	.....	.....	.....	.....
	New Jersey	Hydrogen	.....	.....	Engineering	.....	.....	Chemico	Chemico
Esso Standard	Bayway, N.J.	Exp. Cat Cracker Light Ends	.....	.....	Under Constr	Early 1960	.....	.....	.....
	Bayonne, N.J.	*Asphalt	.....	.....	Under Constr	Spring 1960	.....	.....	.....
Frontier Refining	Jacksonville, Fla.	*Refinery	10,000 bbls	.....	Planning	.....	.....	.....	.....
Foster Grant	Leominster, Mass.	*Plastic Polymers, Copolymers, Styrene Monomer, Molded Plastics	.....	$4,000,000	Planning	.....	.....	.....	.....
Grace Chemical Div., W.R. Grace	Memphis	Exp. Urea	300 tons	.....	Complete	.....	.....	Grace	Process Contracting
		*Exp. Ammonia	450 tons	.....	Under Constr	Mid 1961	.....	.....	.....
Gulf Oil	Philadelphia	Oxo Alcohols	.....	.....	Under Constr	Dec 1960	Gulf Oil	BadgerMfg/Gulf	BadgerMfg/Gulf
Hercules Powder	Burlington, N.J.	*Dimethyl Terphthalate	36,000,000 lbs/yr	.....	Under Constr	Oct 1960	.....	.....	.....
Novamont	Neal, W. Va.	*Isotactic Polypropiene, Other Petrochemicals	22,000,000 lbs/yr	.....	Under Constr	Early 1961	Montecotini	Staff	Staff
Pantasote	Passaic, N.J.	Polyvinyl Chloride	.....	.....	Under Constr	1960	SD	SD	SD
Pittsburgh Coke & Chemical	Neville Island, Pa.	*Maleic Anhydride	20,000,000 lbs/yr	.....	Planning	Early 1961	.....	SD	SD
Quaker State Oil Refining	Farmers Valley, Pa.	Exp. Refinery	.....	$400,000	.....	.....	.....	.....	.....
Reichhold Chemicals	Elizabeth, N.J.	Maleic Anhydride	20,000,000 lbs/yr	$4,000,000	Engineering	June 1960	Badger Mfg.	Badger Mfg.	Badger Mfg.
		*Phthalic Anhydride	30,000,000 lbs/yr	$5,000,000	Complete	.....	Badger/ Sherwin Williams	Badger/	Badger/
	Hampton, S.C.	Formaldehyde	30,000,000 lbs/yr	.....	Engineering	.....	.....	.....	.....
	Tuscaloosa	Formaldehyde	35,000,000 lbs/yr	.....	Planning	.....	Staff	Staff	Staff
Shell Oil	Little Creek, Miss.	Nat. Gas Liquids	5-MMcf	.....	Planning	.....	.....	.....	.....
Sinclair	Marcus Hook	Hydrodesulfurizer	20,000 bbls	.....	Complete	.....	.....	Catalytic	Catalytic
Stauffer Chemical	Le Moyne, Ala.	Methane Purification	.....	.....	Engineering	Spring 1960	.....	Treco	Treco
	Delaware City, Del.	*Carbon Bisulfide	.....	.....	Planning	Nov 1960	.....	Staff	
Sun Oil	Marcus Hook	Furnace Oil Desulfurizer	15,000 bbls	$1,257,000	Complete	.....	.....	Staff	Staff
		Propylene Fractionating	60,000,000 lbs/yr	$1,965,000	Under Constr	1960	.....	Staff	Staff, others
		Exp & Modernize Grease Plant	.....	$450,000	Under Constr	1960	.....	Staff	Staff
		Exp. Wax Moulding and Packaging	.....	$637,000	Under Constr	1960	.....	Staff	Staff
		Automatic Tank Gauging	.....	$428,000	Under Constr	Spring 1960	.....	Staff	Staff
		Chassis Dynamometer Addition	.....	$352,000	Under Constr	1960	.....	Staff	Staff, others
		Automatic Crude Blending	.....	$230,000	Under Constr	1960	.....	Staff	Staff
SunOlin Chem.	North Claymont, Del.	Urea	200 tons	$8,000,000	Under Constr	Early 1960	.....	Kellogg/Staff	Kellogg
Tennessee Eastman	Kingsport, Tenn.	High-Purity Hydrogen	900 Mcf	.....	Under Constr	Early 1960	.....	Girdler	Girdler
Union Carbide Chemicals	Institute, W. V.	Exp. Acrylonitrile	.....	.....	.....	.....	.....	.....	.....

Mid-Continent

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Ashland O & R	Canton, Ohio	*Gas Revamp	.....	.....	Planning	Dec 1960	.....	.....	.....
Aurora Gasoline	Detroit	Vacuum Distl.	18,000 bbls	.....	Under Constr	1960	.....	Treco	Treco
		Naphtha Unifining	8,000 bbls	.....	Under Constr	1960	UOP	Treco	Treco

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 230

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Bay Refining	**Bay City, Mich.**	**Crude Distl.**	**12,000 bbls**	**$900,000**	**Complete**	.....	.....	**Sweco**	**Sweco**
		Alkylation	**850 bbls**	**$850,000**	**Complete**	.....	**UOP**	**Sweco**	**Sweco**
Century Refining	**Garden City, Kan.**	**Catalytic Cracking**	**3,000 bbls**	.....	**Under Constr**	**May 1960**	**Socony**	**Litwin**	**Litwin**
		Gas Concentration	.....	.....	**Under Constr**	**May 1960**	.....	**Litwin**	**Litwin**
		C_3-C_4 HF Alkylation	**800 bbls**	.....	**Under Constr**	**May 1960**	**Phillips**	**Litwin**	**Litwin**
Cooperative Farm Chemicals	**Lawrence, Kan.**	**Ammonia**	**100 tons**	**$5,400,000**	**Under Constr**	**1960**	.....	**Chemico**	**Chemico**
		Urea	**30 tons**						
		Nitric Acid	**130 tons**	**$1,250,000**	**Under Constr**	**Feb 1960**	.....	**Chemico**	**Chemico**
Derby Refining	**Wichita, Kan.**	**Alkylation**	**1,700 bbls**	**$1,500,000**	**Complete**	.....	.....	**Procon**	**Procon**
Dow Chemical	**Bay City, Mich.**	**Polyethylene, Polypropylene**	.....	.....	**Complete**	.....	.....	**Bechtel**	**Austin**
Du Pont	**Circleville, Ohio**	**Polyester**	.....	.....	**Under Constr**	**Early 1960**	.....	.....	.....
DX Sunray	**Duncan, Okla.**	**Cat Cracker Revamp**	.....	**$600,000**	.....	.....	.....	.....	**Treco**
	Tulsa	**MEK, Solvent Dewaxing & Deoiling**	**5,835 bbls**	**$7,500,000**	**Under Constr**	**Sep 1960**	**Texaco**	**Foster Wheeler**	**Foster Wheeler**
Goodyear Tire & Rubber	Akron, Ohio	*Exp. Extruded Polyvinyl Chloride	.....	.....	Planning	.....	.....	.....	.....
Grace Chemical Div. W. R. Grace	**Memphis, Tenn.**	**Exp. Urea**	**300 tons**	.....	**Under Constr**	**1960**	.....	**Foster Wheeler**	**Process Contracting**
Great Northern Oil	**Pine Bend, Minn.**	**Sulfuric Acid Alklation**	**2,000 bbls**	.....	**Under Constr**	**Fall 1960**	**UOP**	**Treco**	**Treco**
Gulf Oil	**Cleves, Ohio**	**Distillate Treater**	**11,000 bbls**	.....	**Under Constr**	**1960**	**UOP**	**McKee**	**McKee**
	Toledo, Ohio	**Distillate Treater**	**16,000 bbls**	.....	**Under Constr**	**1960**	**Petrico**	**Staff/Kaighin-Hughes**	**Staff/Kaighin-Hughes**
		*Crude and FCCU Revamp	.....	.....	**Under Constr**	**1960**	**Gulf/Kellogg**	.....	**Kaighin-Hughes/Kellogg**
Kerr-McGee	**Wynnewood, Okla**	**Exp Crude**	**25,000 bbls**	.....	**Under Constr**	**Feb 1960**	.....	**Litwin**	**Kaighin-Hughes/Litwin**
		Vacuum Distl	**10,625 bbls**	.....	**Under Constr**	**Feb 1960**	.....	**Litwin**	**Kaighin-Hughes/Litwin**
		FCCU Revamp, TEL Blending	.....	.....	**Under Constr**	**Feb 1960**	.....	**Litwin**	**Kaighin-Hughes/Litwin**
Lion Oil, Division of Monsanto	El Dorado, Ark.	**Unifiner—Platformer**	**5,000 bbls**	.....	**Engineering**	.....	**UOP**	**UOP/Procon**	**Procon**
		Tetramer	**340 bbls**	.....	**Complete**	.....	**UOP**	**Procon**	**Procon**
		Exp Refinery	**4,000 bbls**	.....	**Under Constr**	.....	.....	.....	**Staff**
Monsanto Chemical	**Monsanto, Ill.**	**Phenol Exp.**	.....	.....	.....	.....	.....	.....	.....
	El Dorado, Ark.	**Urea Distl.**	.....	.....	**Under Constr**	.....	.....	**Chemico**	**Chemico**
	St. Louis	*Exp. Maleic Anhydride	20,000,000 lbs/yr	.....	Planning	Mid 1960	.....	SD	SD
National Coop Ref. Assoc.	McPherson, Kan.	*Unifiner	5,000 bbls	.....	Engineering	Summer 1960	.....	Staff	Treco
Northwestern Ref.	**St. Paul Park, Minn.**	**Cat Reformer**	.....	.....	**Planning**	**1960**	.....	.....	.....
Ohio Oil	Pulaski, Mich.	*Natural Gasoline	25 MMcf	.....	Under Constr	Mid 1960	.....	.....	.....
Phillips Pet.	**Kansas City, Kan.**	**Alkylation**	**6,600 bbls**	.....	**Under Constr**	**1960**	**Phillips**	**Phillips**	**Procon**
Reichhold Chemicals	**Detroit**	**Formaldehyde**	**35,000,000 lbs/yr**	.....	**Planning**	.....	**Staff**	**Staff**	**Staff**
	Kansas City, Kan.	**Formaldehyde**	**35,000,000 lbs/yr**	**$500,000**	**Complete**	.....	.....	.....	.....
RJ Oil & Ref.	Princeton, Ind.	**Unifiner**	**1,700 bbls**	.....	**Planning**	.....	.....	.....	.....
		Crude Distl.	**5,000 bbls**	.....	**Under Constr**	**1960**	.....	.....	.....
		Platformer	**1,700 bbls**	.....	**Planning**	.....	.....	.....	.....
Shell Oil	**Wood River, Ill.**	**Catalytic Reformer & Offsite Facilities**	**25,000 bbls**	**$15,000,000**	**Under Constr**	**Aug 1960**	.....	**McKee/Parsons**	**McKee/Parsons**
	Healdton, Okla.	**Exp. Plant**	.....	**$315,000**	**Under Constr**	.....	.....	**Staff**	**Hudson**
Sinclair Refining	**East Chicago**	**Alkylation/LPG**	**5,000 bbls**	.....	**Complete**	.....	.....	**Braun**	**Braun**
Skelly Oil	**El Dorado, Kan.**	**Gasoline Treater**	**7,000 bbls**	.....	**Under Constr**	**1960**	.....	**Litwin**	**Staff**
Standard-Indiana	**Whiting, Ind.**	**Vapor Recovery**	.....	.....	**Under Constr**	**1960**	.....	**McKee**	**McKee**
		Vacuum Distl. Tower	**36,000 bbls**	.....	**Complete**	.....	.....	**Braun**	**Staff**
		Exp. Cat Cracker	**10,000 bbls**	.....	**Engineering**	**1960**	.....	**Kellogg**	**Staff**
		*Alkylation	11,400 bbls	.....	Engineering	1961	.....	Bechtel	Bechtel
Standard-Ohio	**Lima, Ohio**	**Exp. Lube Wax Facilities**	.....	**$650,000**	**Complete**	.....	.....	.....	.....
		Acrylonitrile	.....	.....	**Under Constr**	**1960**	.....	**Badger Mfg**	**Badger Mfg**
Sun Oil	Toledo	*Automatic Tank Gauging	.....	$200,000	Under Constr	Spring 1960	.....	Staff	Staff
Sunray Mid-Continent	**McClain County, Okla.**	**Natural Gasoline**	**5 MMcf**	**$1,000,000**	**Complete**	.....	.....	**Pona**	**Pona**
	Purcell, Okla.	*Exp. Natural Gasoline	25 MMcf	$600,000	Engineering	June 1960	.....	Staff/Tuloma	.....
Texaco	**Lawrenceville, Ill.**	**Cat Reformer**	**12,000 bbls**	.....	**Complete**	.....	.....	**Bechtel**	**Betchel**
		Hydrotreater	**12,000 bbls**	.....	**Complete**	.....	.....	**Bechtel**	**Bechtel**
	Tulsa, Okla.	**Alkylation**	**2,050 bbls**	.....	**Complete**	.....	.....	**Staff**	**Kaighin-Hughes**
Union Carbide	**Marietta, Ohio**	*Bisphenol-A	25,000,000 lbs/yr	.....	**Under Constr**	**Early 1961**	.....	.....	.....
	Whiting, Ind.	**Low-density Polyethylene**	**72,000,000 lbs/yr**	.....	**Under Constr**	**1960**	.....	.....	.....
Vickers	**Potwin, Kan.**	**Water Disposal**	.....	**$200,000**	**Under Constr**	**1960**	.....	**Wilson**	**Sherwood/Litwin**
Warren Petroleum & Sunray	**Forgan, Okla.**	**Gasoline**	**100 MMcf**	**$3,000,000**	**Complete**	.....	.....	.....	**Dresser**
Western Petrochemicals	Chanute, Kan	**Waste Disposal**	.....	.....	**Engineering**	**1960**	.....	**Litwin**	**Litwin**
		Vacuum Distl.	**500 bbls**	.....	**Engineering**	**1960**	.....	**Litwin**	**Litwin**
		Propane Deasphalting	**350 bbls**	.....	**Engineering**	**1960**	.....	**Litwin**	**Litwin**
Witco Chemical	**Chicago**	**Phthalic Anhydride**	**20,000,000 lbs/yr**	.....	**Under Constr**	**1960**	**SD**	**SD**	**SD**

Southwest

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Amarillo Oil/Texaco	Pampa, Texas	*Natural Gasoline	60 MMcf	.....	Under Constr	April 1960	.....	Dresser	Dresser
American Oil	**Texas City**	**Relocated Delayed Coker**	**430 tons**	.....	**Planning**	**1960**	.....	**Tellepsen**	**Tellepsen**
Arkansas Fuel Oil, et al	Kingsville, Texas	*Natural Gasoline	50 MMcf	.....	Complete	.....	.....	.....	.....
Bay Petroleum	Chalmette, La.	*Exp. Refinery	.....	$10,500,000	Under Constr	May 1960	.....	.....	.....
	Rockport, Texas	*Natural Gasoline	50 MMcf	.....	Complete	.....	.....	.....	.....
	New Orleans	**Alkylation**	**2,700 bbls**	.....	**Under Constr**	**Early 1960**	**UOP**	**Bechtel**	**Bechtel**
		Exp Cat Cracker	**15,000 bbls**	.....	**Engineering**	**Early 1960**	**UOP**	**UOP**	**Procon**
		Crude	**35,000 bbls**	.....	**Under Constr**	**Early 1960**	.....	**Bechtel**	**Bechtel**
Bureau of Mines	Keyes, Okla.	*Helium	.....	$10,000,000	Complete	.....	.....	Fluor	Fluor
Carbide & Carbon	**Seadrift, Texas**	**Exp. Ethylene Oxide**	**To 200,000,000 lbs/yr**	.....	**Planning**	.....	.....	.....	.....
	Texas City	*Exp. Polyethylene	.....	.....	Engineering	.....	.....	B&R	.....
		*Exp. Ethylene Glycol	65 MMcf	.....	Planning	.....	.....	.....	.....
Champlin O&R	Enid, Okla.	*Exp. Cat Cracker	20,000 bbls	.....	Under Constr	1960	Kellogg	Staff/Kellogg	Staff
		*Exp. Alkylation	2,000 bbls	.....	Under Constr.	1960	Kellogg	Staff/Kellogg	Staff

* First appearance in tabulation.

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Copolymer Rubber & Chemical	Baton Rouge	Exp. Butadiene	35,000 short tons yr	.....	Under Constr	.....	.....	.....	.....
CM&M Gas Products	Wise County, Texas	Exp. Gas Processing, Liquid Recovery	150 MMcf	$700,000	Under Constr	1960	.....	.....	.....
Dow Chemical.....	Freeport, Texas	Acrylonitrile	.....	.....	Planning	.....	.....	.....	.....
		*Styrene-Butadiene Latexes	.....	.....	Engineering	1961	.....	.....	.....
		*Anhydrous Ammonia	.....	.....	Planning	Early 1960	.....	.....	.....
	Plaquemine, La.	Polyethylene	.....	$12,000,000	Under Constr	Late 1960	ICI	.....	.....
		Vinylidene Chloride	.....	.....	.....	.....	.....	.....	.....
		Methyl Chloriform	.....	.....	.....	.....	.....	.....	.....
Du Pont.	Orange	Polyethylene	.....	.....	Under Constr	.....	.....	.....	.....
	Beaumont	Caprolactam	50,000,000 lbs/yr	.....	Planning	Late 1960	.....	Staff	Staff
		*Acrylonitrile	.....	.....	Under Constr	Spring 1961	Staff	Staff	Staff
El Paso Natural Gas.	Terrell County, Texas	*Treating	220 MMcf	$4,827,000	Planning	.....	.....	.....	.....
Esso Standard Oil. . .	Baton Rouge, La.	*Exp. Butyl Rubber	.....	.....	Complete	.....	.....	.....	.....
Firestone.....	Orange, Texas	Polyisoprene, Polybutadiene	30,000 tons/yr	.....	Engineering	.....	.....	.....	.....
Goliad-Union Oil of Cal.....	Vermillion Parish, La.	*Natural Gasoline	450 MMcf	$4,000,000	Planning	.....	.....	Fluor	Fluor
Gulf Oil.....	Port Arthur	Deisobutanizer	10,000 bbls	.....	Under Constr	1960	.....	Treco	Treco
		High Purity Ethylene	1,400,000 lbs	.....	Engineering	Summer 1960	.....	Kellogg/Gulf	Kellogg/Gulf
		*Oxo Preparation	.....	.....	Under Constr	1960	.....	Staff/Treco	Treco
Humble.....	Baytown, Texas	Polyolefin	40,000 lbs/yr	.....	Under Constr	1960	.....	Esso	Staff
		*Exp Lube Hydrofiner, Dewaxing, Extraction	9,500 bbls	.....	Planning	Late 1960	.....	.....	.....
	Rusk County, Texas	Remote Absorber	80 MMcf	.....	Complete	.....	.....	Staff	Staff
	Kleberg County, Texas	Gas Process & Cycling	800 MMcf	.....	Under Constr	1960	.....	Staff	Hudson
Hunt Oil.....	Alta Loma, Texas	*Natural Gasoline	.....	.....	Planning	.....	.....	Hudson	Hudson
Koppers.....	Port Arthur	Exp. Polyethylene	.....	.....	Under Constr	1960	Staff	Staff	Staff
La Gloria Oil & Gas..	Tyler, Texas	Gas Concentration; Revamp Cat Cracker	.....	.....	Complete	.....	UOP	UOP	B & R
	Acadia Parish, La.	LPG	176 MMcf	.....	Under Constr	Early 1960	.....	B & R	B & R
		Natural Gasoline							
McBride Refining....	Brownsville, Texas	Refinery Exp.	12,500 bbls	$2,500,000	Planned	.....	.....	.....	.....
Mobil Oil.....	Beaumont, Texas	*Cat Reforming	20,000 bbls	.....	Under Constr	1960	.....	Fluor	Fluor
		*Ethylene	380,000,000 lbs/yr	.....	Under Constr	1961	.....	Kellogg	Kellogg
	Cameron Parish, La.	*Natural Gasoline, Distillates	150 MMcf	$2,500,000	Complete	.....	.....	.....	.....
		*Exp. Polyethylene	12,500 bbls	$2,500,000	Planning	.....	.....	.....	.....
Monsanto.....	Texas City	Exp Polyethylene	100,000,000 lbs/yr	.....	Complete	.....	.....	.....	.....
Pan American Pet....	North Cowden, Texas	Exp. Gas Compression	.....	.....	Under Constr	1960	.....	Staff	B & R
	Old Ocean, Texas	*Exp. Refinery	.....	.....	Engineering	Late 1960	.....	B & R	B & R
Phillips Chemical.....	Borger, Texas	Multi-Purpose Chemicals	.....	.....	Engineering	.....	.....	Staff	Staff
	Pasadena, Texas	Exp. Methylvinylpyridine	.....	.....	Under Constr	.....	.....	Staff	Staff
	Sweeny, Texas	Exp. Ethylene	.....	.....	Under Constr	1960	.....	Staff	Staff
Phillips Petroleum....	Sweeny, Texas	Hexane Isomerisation	1,000 bbls	.....	Under Constr	1960	.....	Staff	Staff
	Kansas City	H.F. Alkylation	6,600 lbs	.....	Under Constr	1960	Phillips	Staff	Staff
	Borger	*Heavy Oil Cat Cracking	25,000 bbls	.....	Planning	Early 1961	.....	Kellogg	Kellogg
Reichold Chemical....	Houston	Petrochemicals	.....	.....	Complete	.....	.....	B & R	B & R
Shamrock Oil & Gas..	Sunray, Texas	TCC	8,000 bbls	.....	Under Constr	Spring 1960	.....	Fluor	Fluor
Shell Oil.....	Deer Park, Texas	*Distillate Hydrotreater & Offsite Facilities	30,000 bbls	$3,500,000	Under Constr	Mid 1960	.....	Fluor	Fluor
	Weeks Island, La.	Nat. Gas Processing	120 MMcf	.....	Complete	.....	.....	.....	.....
	Sheridan, Texas	*Gas Cycling	150 MMcf	$1,000,000	Planning	Late 1960	.....	.....	.....
Shell Chemical.....	Norco, La.	Acrolein	.....	.....	Under Constr	.....	.....	.....	.....
		Glycerine	.....	$4,500,000	Under Constr	1960	.....	Staff	Parsons/Fluor
	Houston	Phenol	.....	.....	Complete	.....	.....	.....	Kellogg
Sinclair Refining.....	Hulldale Field, Texas	Desulfurizer	.....	.....	Under Constr	.....	.....	.....	.....
South Louisiana Production	Jeanerette, La.	*Butane, Propane, Other LPG	.....	.....	Under Constr	.....	.....	.....	.....
Spencer Chemical....	Orange, Texas	Exp. Polyethylene	90,000,000 lbs/yr	.....	Under Constr	Summer 1960	.....	Staff	Quaker Valley
Sunray Mid-Continent	Jackson County, Texas	Propane Isobutane Butane Natural Gasoline	27,000 gals	.....	Complete	.....	.....	.....	.....
	Bossier Parrish, La.	Exp Recovery Facilities	500 MMcf	$500,000	Planning	Sept 1960	.....	.....	.....
Texas Eastman.....	Longview, Texas	Exp. Oxo, Normal Butyraldehyde, Iso-butyraldehyde	125,000,000 lbs/yr	.....	.....	.....	.....	Staff	Hudson
Texas Gulf Producing	Ector-Midland Counties	Natural Gas Liquids & Compression	.....	.....	Complete	.....	.....	B & R	B & R
Texaco.....	Port Arthur	Cat Reformer	20,000 bbls	.....	Complete	.....	.....	UOP	Staff & Fluor
		Udex	28,000 bbls	.....	Complete	.....	.....	UOP	Staff & Fluor
	El Paso	Alkylation	1,600 bbls	.....	Complete	.....	.....	Texaco	Swetex
Texas Alkyls.....	Houston	Detergents	.....	.....	Under Constr	Late 1960	.....	Staff	B & R
		Special Chemicals	.....	.....	.....	.....	.....	.....	.....
Texas Natural Gasoline.....	Arcadia, Parish, La.	CGT Gas Line, Natural Gas Liquid	.....	.....	Under Constr	Early 1960	.....	Fluor	Fluor
Tidewater Oil.....	Franklin County Texas	Cycling	50 MMcf	.....	Engineering	Early 1960	.....	B & R	B & R
		Natural Gasoline							
		Sulfur Recovery	250 tons	.....	Engineering	Early 1960	.....	B & R	B & R
	Houma, La.	*Natural Gasoline	75 MMcf	$1,500,000	Under Constr	Late 1960	.....	Olsen	Olsen
Transwestern Pipeline	Pecos County,	Gas Treating	180 MMcf	.....	Under Constr	1960	Giammarco-Vetrocoke	B & R	B & R
Union Carbide.....	Seadrift. Texas	Ester & Alcohol	100,000,000 lbs/yr	.....	Engineering	1960	.....	.....	.....
		Exp. Petrochemicals	.....	.....	Under Constr	1960	.....	Staff	B & R
	Brownsville, Texas	*Chemical Solvents, Intermediates	.....	.....	Under Constr	March 1961	.....	.....	.....
United Rubber & Chemical	Baytown, Texas	Synthetic Rubber	.....	.....	Under Constr	.....	.....	Day & Zimmerman	Tellepsen
U.S.I.C.....	Houston	Exp. Polyethylene	200,000,000 lbs/yr	.....	Under Constr	Mid 1960	ICI	Kellogg	Kellogg
Warren Petroleum....	Atascosa County, Texas	*Sulfur Recovery	50 long tons	$550,000	Engineering	Mid 1960	.....	Graff Engineering	Delta Engineering
Western Nat. Gas....	Brownsville, Texas	Refinery Revamp	3,500 bbls	.....	Under Constr	.....	.....	.....	Staff
	Edinburg, Texas	*Gas Processing	60 MMcf	.....	Under Constr	April 1960	.....	.....	Tuloma Builders
	Nursery, Texas	*Gas Processing	10 MMcf	.....	Engineering	July 1960	.....	.....	.....

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Construction BOXSCORE Continued on Page 232

Rocky Mountain

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Dow Chemical	Torrance, Cal.	*Polypropylene	.....	.....	.....	1961	.....	.....	.....
El Paso Natural Gas	Jal, N.M.	*Exp. Natural Gasoline	210 MMcf	$1,266,000	Under Constr	April 1960	.....	Dresser	Dresser
Husky Oil	Cody, Wyo.	*Refinery	9,000 bbls	.....	Under Constr	.....	.....	.....	.....
Pan American Petroleum/Hondo Oil & Gas	Eddy County, N.M.	*Natural Gasoline	15 MMcf	.....	Under Constr	Mid 1960	.....	Olsen	Olsen
Phillips	Artesia, N.M.	*Natural Gasoline	35 MMcf	.....	Under Constr	Fall 1960	.....	.....	.....
Southwestern Nitrochemical	Chandler, Ariz.	*Ammonia Synthesis	80 tons	$4,000,000	Under Constr	Feb 1960	.....	Chemico	Chemico
Texaco	Casper, Wyo.	*Hydrotreater	4,500 bbls	.....	Engineering	August 1960	.....	Texaco	Badger

West Coast

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
California Ammonia	Lathrop, Cal.	Ammonia Synthesis	100 tons	$5,000,000	Engineering	1960	.....	Macco	Macco
Collier Carbon & Chemical	Los Angeles	*Sulfuric Acid	250 tons	.....	Engineering	Late 1960	Leonard/Monsanto	Braun/Leonard/Monsanto	.....
		*Ammonium Sulfate	150 tons	.....	Engineering	Late 1960	.....	Ebhart	
	Rodeo, Cal.	*Carbon Calcining	.....	.....	Under Constr	Fall 1960	.....	.....	.....
	Wilmington, Cal.	*Sulfuric Acid	.....	.....	Engineering	Sept 1960	Monsanto	Braun/Leonard	Braun
Du Pont	Antioch, Cal.	Fluorinated Hydrocarbons, Tetraethyl Lead	.....	.....	Under Constr	.....	.....	.....	.....
Mobil Oil	Torrance, Cal.	Exp Delayed Coker	9,300 bbls	.....	Under Constr	Feb 1960	.....	Bechtel/Staff	Bechtel
Reserve Oil & Gas Standard	Kern County, Cal.	*Natural Gasoline	35 MMcf	.....	Complete	.....	.....	Parkersburg Rig & Reel	Parkersburg Rig & Reel
Richfield	Watson, Cal.	Gas Plant Revamp	.....	.....	Complete	.....	.....	Braun	Braun
		General Facilities Revamp	.....	.....	.....	.....	.....	.....	.....
Shell Development	Emeryville, Cal.	Research Lab.	.....	$500,000	Under Constr	.....	.....	.....	.....
Signal Oil & Gas	Bakersfield, Cal.	Exp. Refinery	20,000 bbls	.....	Under Constr	Late 1960	.....	Parsons	Parsons
Standard Oil (Calif)	Richmond, Cal.	*Maleic Anhydride	20,000,000 lbs/yr	.....	Under Constr	Mid 1960	.....	Badger	Badger
		*Isocracker	1,000 bbls	.....	Complete	.....	Cal Research	Staff/Bechtel	Bechtel
	Honolulu	Refinery	35,000 bbls	$40,000,000	Under Constr	1961	.....	Staff/Bechtel	Bechtel/Hawaiian Dredging
Union Oil	Wilmington, Cal	Unifiner-Reformer	14,000 bbls	.....	.....	.....	.....	.....	.....
		Mid-Barrel Unifiner	20,000 bbls	$17,000,000	Engineering	Fall 1960	Staff	Braun	Braun
		Heavy Cat Unifiner	4,000 bbls	.....	.....	.....	.....	.....	.....
		CO Boiler	240,000 lbs/hr	$2,500,000	Engineering	Late 1960	.....	Fluor	Fluor
		Amine Reactivator	150 tons	$1,600,000	Engineering	Spring 1960	.....	Parsons	Parsons
		H_2S Recovery	.....	.....	.....	.....	.....	.....	.....
Vally Nitrogen	Helm, Cal.	Ammonia	150 tons	.....	Engineering	1960	Chemico	Chemico	Chemico
Wilshire	Santa Fe Springs, Cal.	Crude Distillation Revamp	30,000 bbls	.....	Complete	.....	.....	UOP/Braun	Staff/Braun
		Alkylation	1,500 bbls	.....	Engineering	Spring 1960	UOP	UOP/Braun	Staff/Braun

Canada

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
British American Oil	Clarkson, Ont.	Compounding, Blending & Grease	.....	$2,900,000	Under Constr	.....	.....	Nofsinger	Foster Wheeler
		*Distillate Desulfurizer	8,000 bbls	.....	Complete	.....	.....	Canadian Kellogg	Canadian Kellogg
		Alkylation	3,000 bbls	$3,000,000	Under Constr	1960	UOP	UOP	Procon
	Calgary	Exp. Reformer	3,000 bbls	$500,000	Under Constr	1960	.....	Treco	Terco
	Moose Jaw Sask.	Cat Reformer	5,400 bbls	.....	.....	.....	.....	.....	.....
	Pincher Creek, Alb.	*Gas Processing, Sulfur (Stage III)	196 MMcf	$4,000,000	Complete	.....	.....	.....	.....
British Petroleum	Ville d'Anjou	Crude Distl	25,000 bbls	.....	Under Constr	Spring 1960	.....	Lummus	Lummus
		Cat Cracker	9,000 bbls	.....	Under Constr	Spring 1960	UOP	Lummus	Lummus
		Platformer	6,000 bbls	.....	Under Constr	Spring 1960	UOP	Lummus	Lummus
		Cat Desulfurizer	12,000 bbls	.....	Under Constr	Spring 1960	.....	Lummus	Lummus
		Cat Polymerization	700 bbls	.....	Under Constr	Spring 1960	UOP	Lummus	Lummus
Canadian Chemical	Edmonton, Alb.	*Petrochemicals	.....	$4,000,000	Planning	Early 1961	.....	.....	.....
Canadian Hulsey Oil	Fort Williams, Ont.	*Refinery	4,200 bbls	.....	Complete	.....	.....	.....	.....
Canadian Oil	Carunna, Ont.	Unifiner	5,000 bbls	.....	Under Constr	1960	.....	UOP	Procon
	Sarnia, Ont.	*Exp. Refinery	50,000 bbls	$8,000,000	Complete	.....	.....	.....	.....
Canadian Petrofina	Montreal	Exp. Capacity	30,000 bbls	$3,000,000	Complete	.....	.....	Staff	Procon (Canada)
Carstairs Operators Committee	Carstairs, Alb.	Gas Processing	66 MMcf	$3,500,000	Under Constr	Spring 1960	.....	Fluor	Fluor

* First appearance in tabulation.

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Consolidated Smelting	Calgary, Alb.	Urea	100 tons	.....	Engineering	Mid 1960	Inventa/Vulcan	Vulcan	.....
Cyanamid of Canada	Welland, Ont.	Nitric Acid	190 tons	.....	Engineering	1960	Uhde	McKee	McKee
Devon Palmer-Texas Gulf Sulfur	Okotoba, Alb.	*Sulfur Recovery	370 long tons	$8,000,000	Complete	.....	.....	B&R	B&R
Federated Cooperatives	Regina, Sask.	*Platforming Unifying	.....	$2,000,000	Complete	.....	.....	.....	.....
Imperial Oil	Sarnia	Refinery Exp.	94,500 bbls	$3,000,000	Complete	.....	.....	Staff	Staff
	Edmonton, Alb.	Alkylation	1,500 bbls	$2,175,000	Engineering	Feb 1960	.....	.....	.....
	Regina	Powerformer	3,000 bbls	$2,550,000	Under Constr	1960	.....	Canadian Kellogg	Canadian Kellogg
	Calgary, Alb.	*Refinery	14,700 bbls	$14,000,000	Complete	.....	.....	.....	.....
	Winnipeg	Alkylation	650 bbls	$2,200,000	Complete	.....	.....	Canadian Bechte	Canadian Bechtel
Innisfail Operators Committee	Innisfail Field, Alb.	*Refinery	10,000 bbls	.....	Planning	.....	.....	.....	.....
		*Sulfur Recovery	80 tons	.....	Planning	.....	.....	.....	.....
		*Gas Treating	8.7 MMcf	.....	Planning	.....	.....	.....	.....
Irving Refining	St. John, New Brunswick	Hydrogen	.....	.....	Engineering	1960	.....	Girdler Bechtel	Canadian Bechtel
		Crude Desalter	38,500 bbls	.....	Under Constr	1960	Howe-Baker	Bechtel	Bechtel
		Gas Treating-Sulfur Recovery	.....	.....	Engineering	1960	.....	Parsons	.....
		Refinery	40,000 bbls	$45,000,000	Under Constr	1960	.....	Canadian Bechtel	Canadian Bechtel/Fluor
Monsanto, Canada	Villa La Salle, Que.	*Maleic Anhydride	6,000,000 lbs/yr	.....	Planning	Late 1960	.....	SD	SD
Nevis Operators Committee	Nevis, Alb.	Gas Processing	43 MMcf	$3,000,000	Under Constr	1960	.....	Fluor	Fluor
		Sulfur Recovery	125 tons						
Nottingham Gas Carnduff Gas	Saskatchewan	Gas Processing, Treating, Gathering	8.5 MMcf	.....	Engineering	1960	.....	Tellepsen	Tellepsen
Phillips Petroleum	Taylor, B.C.	*Refining	.....	.....	Under Constr	1960	.....	Stearns Roger	Stearns Roger
Shell Oil (Canada)	Bronte, Ont.	Refinery	.....	.....	Planning	.....	.....	Treco/Staff	.....
Sogenines	Maitland, Ont.	Synthetic Nitrogen, Ammonium Nitrate, Nitrogen Solutions, Anhydrous Ammonia	.....	$17,000,000	Planning	1961	.....	.....	.....
Sun O'l Ltd	Sarnia	Exp. Visbreaking	.....	$343,000	Complete	.....	.....	Staff	Catalytic
Texaco, Canada	Montreal	Sulfuric Acid Alkylation Feed Preparation and Treating	2,200 bbls	.....	Engineering	.....	.....	Foster Wheeler	Foster Wheeler
Westcoast Transmission	Coleman, Alb.	Gas Processing	.....	$15,000,000	Planning	.....	.....	.....	.....

Latin America

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
ARGENTINA									
Argentine Government	Santa Fe Province	Naphtha Reforming	.....	.....	Planning	.....	.....	.....	.....
Carbometal	Mendoza	Polyvinyl Choride	4,500 tons/yr	.....	.....	.....	.....	.....	.....
		Acetylene	200 tons/yr	.....	.....	.....	.....	.....	.....
		Plastics	7,500 tons/yr	.....	Planning	.....	Monsanto	Monsanto	Monsanto
Monsanto	Buenos Aires	Phthalic Anhydride	.....	.....	Under Constr	.....	.....	Foster Wheeler	.....
BRAZIL									
Alba	Cubatao	*Synthetic Methanol	30 tons	.....	.....	.....	Inventa/Vulcan	Vulcan-Cincinnati	Vulcan-Cincinnati
Industria Brasileira de Enxofre, S.A.	Copuava, Sao Paulo	*Sulfur Recovery	25 long tons	$300,000	Under Constr	Early 1960	.....	Staff	Staff
North American Solvay	Sao Paulo	Ethylene Purification	20 tons	.....	Under Constr	1960	.....	Hydrocarbon	Hydrocarbon/SETAL
Petroleo Brasileiro	Mataripe	Atmospheric & Vacuum Distl. Cat Cracker Gas Recovery, Wax Treating, Lube	37,000 bbls	.....	Under Constr	1960	Kellogg	Kellogg	Kellogg/Brasileira/Montreal, S A
	Rio de Janeiro	Refinery	90,000 bbls	$60,000,000	Under Constr	1961	.....	Foster Wheeler	.....
	Duque De Caxias Estad. Do Rio de Janeiro	Synthetic Rubber	40,000 tons	.....	Under Constr	1962	.....	.....	.....
	Cubatao-Sao Paulo	Exp. Refinery	90,000 bbls						
		Cat Reformer	12,000 bbls	$10,000,000	Planning	Mid 1962	.....	.....	.....
		Aromatics Extr.	3,000 bbls						
		Ethane Cracking	3.77 MMcf						
Union Carbide	Cubatao	Polyethylene	.....	.....	Complete	.....	.....	B & R	B & R
CHILE									
Empresa Nacional del Petroleo	Concon	Refinery Exp:							
		Crude Topping	24,000 bbls						
		Vacuum	10,080 bbls						
		Orthoflow FCC	12,000 bbls	$15,000,000	Under Constr	1960	Kellogg	Kellogg	Staff & Kellogg
		SBK Cat Reforming and Desulfurization	6,000 bbls						
		Alkylation	1,100 bbls						
COLOMBIA									
Empresso Colombiana de Petroleos	Barranca-Bermeja	Exp. Propane Recovery	1,000 bbls	$1,000,000	Planning	.....	.....	.....	.....
	El Centro	Natural Gasoline	51.4 MMcf	$2,700,000	Under Constr	1960	.....	Parsons	Parsons
ECUADOR									
Anglo-Ecuadorian Oilfields	Santa Elena	Atomspheric Distl.	7,700 bbls	$4,500,000	Under Constr	Early 1960	UOP	Procon	Procon
	Ancon	Thermal Cracking	6,000 bbls	.....	Under Constr	.....	UOP	Procon	Procon
GUATAMALA									
Breaux Oil Refg.	Bridge Puerto Barrios	Refinery	4,000 bbls	.....	Planning	.....	.....	Lummus	Lummus
MEXICO									
Pemex	Minatitlan	Anhydrous Ammonia,	200 tons	$8,000,000	Engineering	Late 1960	.....	Fluor	Fluor
		Crude, Cat Cracking, BTX	27,000 bbls	$23,000,000	Engineering	Mid 1961	UOP	Fluor	Fluor
	Atzcapotzalco	Dodecylbenzene	40.5 tons	$2,000,000	Complete	.....	UOP-Phillips	McKee	McKee
	Salamanca	Anhydrous Ammonia	200 tons	$8,000,000	Engineering	Late 1961	.....	Lummus	Lummus
		Cat Cracking, Exp. Refinery	20,000 bbls	$13,000,000	Engineering	Late 1961	Socony	Lummus	Lummus
		Grease	25 tons	$2,100,000	Engineering	Mid 1961	.....	McKee	McKee

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 234

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Pemex	C. Madero	Topping, Cat Cracking Gas Recovery	110,000 bbls	$43,000,000	Under Constr	Mid 1960	Esso. UOP	McKee	McKee
	Poza Rica	Topping	15,000 bbls	$5,000,000	Under Constr	Late 1960	.....	McKee	McKee
NETHERLANDS ANTILLES									
Lago Oil & Transport	Aruba, N. A.	Revamp Distl. & Visbreaking	.....	.....	Under Constr	1960	.....	Kellogg	Kellogg
PANAMA									
Refiner a Petroquimica de Panama	Portobelo	Refinery	55,000 bbls	$40,000,000	Engineering	1961	.....	Foster Wheeler	Foster Wheeler
Refineria Panama, S A	Las Minas Bay Colon	Refinery; Petrochemicals	70,000 bbls	$59,000,000	Under Constr	Late 1960	.....	Kellogg	.....
PARAGUAY									
Compagnie Fives-Lille	Asuncion, Paraguay	Refinery	10,000 bbls	.....	Planning	.....	.....	.....	.....
PUERTO RICO									
Commonwealth Oil Refining	Guayanilla Bay	Ref. Modifications	75,000 bbls	$6,300,000	Under Constr	1960	.....	UOP	Procon-Others
Union Carbide Caribe	Ponce	Ethylene-Glycol	500,000 lbs	$28,500,000	Complete	.....	.....	B & R	B & R
TRINIDAD									
Federation Chemicals,	Point Lisas	Nitrogen	100 tons				Kellogg/ Stamicarbon/ Monsanto	Braun/Kellogg/ Leonard	Braun
		Urea	70 tons						Braun
		Ammonia	100 tons	$12,000,000	Complete	.....			Braun
		Sulfuric Acid	200 tons						Braun
		Ammonium Sulfate	245 tons				Stami-Carbon	Braun	Braun
Texaco Trinidad	Pointe-a-Pierre	Crude Distl.	15,000 bbls	.....	Under Constr	.....	UOP	Procon	Procon
		*Crude Topping	100,000 bbls	.....	Under Constr	Late 1960	.....	Fluor	Caribbean Bechtel
		*Cat Reformer	15,000 bbls	.....	Under Constr.	Late 1960	.....	Fluor	Caribbean Bechtel
		*Hydrotreater	20,000 bbls	.....	Under Constr	Late 1960	.....	Staff	Caribbean Bechtel
URUGUAY									
Administracion	Montevideo	Crude Desalter	28,000 bbls	$12,000,000	Under Constr	1960	Howe-Baker	Kellogg/Staff	
Nacional de Combustibles Alcohol Y Portland		Vac. Distl.	10,000 bbls	.....	.....	.....	.....		
		Cat Cracker	5,000 bbls	.....	.....	.....	.....		
		Cat Reformer	3,000 bbls	.....	.....	.....	.....	Kellogg-/Staff	Staff
		Gas Concent. & Bottling	.....	.....	.....	.....	.....		
		Gas Sweetening	4,500 bbls	.....	.....	.....	.....		
		Sulfur Recovery	6 tons	.....	.....	.....	.....		
		Power & Offsite Facil.	3,600 KW	.....	.....	.....	.....		
VENEZUELA									
Cia Shell	Cardon	Distl.	80,000 bbls	$20,000,000	Under Constr	.....	.....	.....	.....
		Alkylation	2,800 bbls	.....	Under Constr	.....	.....	.....	.....
Mene Grande Oil	Eastern Venesuela	Compressor Stations	.....	.....	Engineering	Early 1960	.....	B & R	.....
Socony Mobil	El Palito	Refinery	50,000 bbls	$28,000,000	Under Constr	1960	.....	Kellogg	Kellogg
	Eastern Venesuela	Compressor Stations	.....	.....	Engineering	.....	.....	B & R	.....
Venesuela Gulf Refg.	Puerto la Cruz	Crude Distl.	65,000 bbls	.....	Complete	.....	.....	Foster Wheeler	Foster Wheeler

Europe and Africa

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
AUSTRIA									
Austrian Oil Administration	Schwechat near Vienna	Crude Distl. Cat Reformer, Gas Recovery, Chemical	35,000 bbls 7,000 bbls	$22,300,000	Engineering	1960	.....	Lurgi	Lurgi
Danubia Petrochemie A. G.	Schwechat near Vienna	Polypropylene	11,000,000 lbs/yr	.....	.....	.....	.....	.....	.....
BELGIUM									
Amoco Fina	Antwerp	*Petroleum Additives	.....	.....	Planning	Early 1961	.....	.....	.....
AE & CI	Modderfontein	Synthetic Ammonia	70,000 tons	.....	Under Constr	1960	.....	Staff/ICI/ Power-Gas	Power-Gas
British Chrome & Chemicals	Urlay Nook	Sulfuric Acid	100 tons	.....	Under Constr	1960	Chemiceban	Power-Gas	Power-Gas
Carbochimique	Tertre	Partial Oxidation Synthesis Gas	100-500 tons NH_3	.....	Under Constr	1960	Texaco	Power-Gas	.....
		High Pressure CO Conversion	100-150 tons NH_3	.....	Under Constr	1960	Texaco	Power-Gas	Power-Gas
Cobemam, S.A.	Antwerp	Polyethylene	15,000 tons/yr	.....	Plannins	Mid 1960	.....	Union Carbide	Union Carbide
CANARY ISLANDS									
Cepsa	Las Palmas	Ammonia	90 tons	.....	Engineering	.....	Hoechst	Uhde	Uhde
		Ammonium Sulfate	365 tons	.....	Engineering	Mid 1960	Uhde-Texaco	Uhde	Uhde
DENMARK									
Dansk Veedol	Kalundborg	*Refinery	20,000 bbls	.....	Planning	1961	.....	.....	.....
ENGLAND									
Esso Petroleum	Milford Haven	Atmospheric Distl	100,000 bbls						
		Powerformer	16,500 bbls						
		Hydrofiner	16,500 bbls	.....	Under Constr	Late 1960	.....	Foster Wheeler	Foster Wheeler
		Electric Coalescer	31,500 bbls						
		Other Auxiliaries	.....						
	Fawley	*Petroleum Additives	.....	.....	Under Constr	.....	.....	Foster Wheeler	Foster Wheeler
Imperial Chemical Industries	Heysham	Electrostatic Desulfurization	1,150 bbls	.....	Complete	.....	Howe-Baker	Kellogg	Kellogg
	Wilton	*Olefins	110,000 tons/yr	.....	Complete	.....	.....	.....	.....
Malta Gas Board	Valetta	Catalytic Oil Gasification	1 MMcf	.....	Under Constr	1960	.....	Power Gas	Power Gas
Mobil Oil Co., Ltd.	Coryton	Crude Unit Exp.	5,000 bbls	.....	Under Constr	.....	.....	Staff	Staff
Monsanto	Newport	Maleic Anhydride	15,000,000 lbs/yr	.....	Under Constr	Late 1960	SD	SD	SD
Northern Gas Board	Darlington	Catalytic Oil Gasification	2 MMcf	.....	Under Constr	.....	.....	Power-Gas	Power-Gas
North Eastern Gas Board	Whitby	*Natural Gas Reforming	1.25 MMcf	.....	Engineering	1960	Hercules	Power-Gas	Power-Gas
North Thames Gas Board	Romford	Refinery Tail Gas Reforming	36 MMcf	.....	Under Constr	.....	.....	H & G	H & G
North Western Gas Board	Manchester Partington	Pressure Oil Gasification	7.5 MMcf	.....	Engineering	1960	Texaco/ others	H & G	H & G
Petrochemicals	Partington, Nr. Manchester	Exp. Ethylene	30,000 tons/yr	.....	Engineering	.....	.....	H W P	H W P
	Partington	Ethylene Oxide	25,000 tons/yr	.....	.....	.....	.....	.....	.....
Shell Refining	Shell Haven	Hydrodesulfurizer & Gerbotol Modifications	.....	.....	Under Constr	1960	.....	Lummus	Lummus
	Stanlow	Udex	.....	.....	.....	.....	UOP	.....	.....

* First appearance in tabulation.

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
South Eastern Gas	Isle of Grain	Hydrogen	18 MMcf	.....	Under Constr	Late 1960	.....	Woodall-Duckham	Woodall-Duckham
Southern Gas Board	Southampton	Refinery Tail Gas Reforming	16 MMcf	.....	Under Constr	.....	.....	H & G	H & G
	Reading	Catalytic Oil Gasification	7 MMcf	.....	Under Constr	1960	.....	Power Gas	Power Gas
Union Carbide	Fawley	Ethylene Oxide & Derivatives	.....	.....	Under Constr	.....	.....	.....	.....
FRANCE									
Antar-Petroles de l'Atlantique	Donges	*Crude Topping	62,000 bbls	.....	Planning	.....	.....	.....	.....
Compagnie de Raffinage Shell Berre	Petit Couronne	Distl.	80,000 bbls	.....	Under Constr	.....	.....	.....	.....
		Hydrodesulfuriser	11,000 bbls	.....	Under Constr	1960	.....	.....	.....
		Platformer	14,000 bbls	.....	Engineering	1960	.....	Procon	Procon
	Berre l'Etang	Furfural	3,500 bbls	.....	Under Constr	.....	.....	Foster Wheeler	Foster Wheeler
Comp Francaise de Raffinage	Gonfreville l'Orcher	Ethylene	30,000 tons/yr	.....	Under Constr	1960	.....	Kellogg Int'l.	.....
Compagnie Francaise de Petrole; Compagnie Francise de Raffinage; Pechelbronn	Strasbourg	Refinery	70,000 bbls	.....	Planning	.....	.....	.....	.....
Esso Standard	Port Jerome	Powerformer	11,900 bbls	.....	Complete	.....	Esso	Foster Wheeler	Foster Wheeler
		Steam Cracker	5,000 bbls	.....	Complete	.....	Esso	Foster Wheeler	Foster Wheeler
		Dodecylbenzene	13,500,000 tons/yr	.....	Complete	.....	Esso	Foster Wheeler	Foster Wheeler
		*Additives Plant	.....	.....	Under Constr	Early 1960	.....	Foster Wheeler	Foster Wheeler
Houilleres du Bassin de Lorraine	Carling	Acetylene	.....	.....	Under Constr	.....	.....	SBA	SBA
		Styrene Monomer	.....	.....	Under Constr	1960	.....	SBA	SBA
Manufacture Normande de Polyethylene	Gonfreville	Polyethylene	.....	.....	Complete	.....	Phillips	.....	S T E C
Methanolacq	Pardies, pres Lacq	*Methanol	100 tons	.....	Under Constr	May 1960	.....	Kuhlmann/STEC	.....
Marles-Kuhlmann	Gonfreville	Ethylene Oxide	.....	.....	Under Constr	.....	S D	Staff	.....
Mobil Oil Francaise	Gravenchon	Lube Exp.	.....	.....	Engineering 2nd phase	.....	.....	.....	.....
					Planning 3rd phase	1960	.....	.....	.....
Naphtachimie	Lavera	Ethylene Oxide Exp.	60,000,000 lbs/yr	.....	Engineering	1960	S & W	S & W	SFST
		*Exp. Butadiene Recovery	.....	.....	Planning	.....	.....	Foster Wheeler	Foster Wheeler
Omnium Francais de Petroles		Refinery	75,000 bbls	.....	Planning	.....	.....	.....	.....
Pechiney/Dow	Ribecourt	*Polystyrene	.....	.....	Planning	1961	.....	.....	.....
Potasse et Engrais Chimiques	Grand Coronne	Ammonia	.....	.....	.....	.....	.....	Kellogg	Kellogg
Societe des Produits d'Aquitaine	Chimique	Ammonia	200 tons	$6,000,000	Engineering	1960	.....	Chemico	Chemico
	Lacq	Acetylene from Nat. Gas	75 tons	.....	Under Constr	.....	BASF	BASF/Heurtey	Heurtey
Soc. Francaise des Petroles BP	Lavera	Selective Hydrogenation	3,500 bbls	.....	Engineering	April 1960	.....	.....	Technip
Soc. Nationale des Petroles D'Aquitaine	Lacq	Desulfurization	140 MMcf	.....	Under Constr	.....	.....	Foster Wheeler Soc Chimique/	Foster Wheeler Soc Chimique
		Desulfurization	175 MMcf	.....	Engineering	1960	.....	Foster Wheeler Soc Chimique/	Foster Wheeler Soc Chimique
		Distillation Recovery II	112 MMcf	.....	Under Constr	1960	.....	Hydrocarbon/ Lummus/	Hydrocarbon/ Lummus/
		Sulfur Recovery Phase II	970 tons	.....	Under Constr	.....	Parsons	Parsons/Heurtey	Parsons/Heurtey
		Sulfur Recovery Phase III	780 tons	$22,000,000	Engineering	1960	Parsons	Parsons/ Heurtey	Parsons/ Heurtey
		Sulfur Recovery Phase IV	1,000 tons	.....	Engineering	1961	Parsons	Parsons/ Heurtey	Parsons/ Heurtey
		Gas Plant Sections 4 & 5	.....	.....	Planning	.....	.....	Lummus	Lummus
		Ethylene	25,000 tons/yr	.....	Engineering	1960	.....	Hydrocarbon	Staff
EAST GERMANY									
Ministry of Coal & Energy	Rostock	Catalytic Oil Gasification	2.4 MMcf	.....	Complete	.....	.....	Power-Gas/ Didier	Power-Gas/ Didier
	Stralsund	Catalytic Oil Gasification	4.8 MMcf	.....	Under Constr	.....	.....	Power-Gas Didier	Power-Gas Didier
WEST GERMANY									
Bodische Anilin & Soda Fabrik	Ludwigshafen	*Olefins	.....	.....	Complete	.....	.....	.....	.....
B.P. Benzin und Petroleum	Dinslaken	Distillation, Cat Reforming, Hydroforming, Copper Chloride	100,000 bbls	.....	Under Constr	1960	.....	Kellogg	.....
Buna Werke Huels	Marl, Kreis Recklinghausen	Synthetic Rubber	45,000 tons/yr	$37,000,000	Complete	.....	Esso; R & E Houdry; Firestone	Staff	Staff
		*Exp. Synthetic Rubber	70,000 tons/yr	.....	Planning	Summer 1960	.....	.....	.....
Chemische Fabrik Holten	Lubwigshaven a Rein	Ethylene Oxide	9,000,000 lbs/yr	.....	Under Constr	.....	S D	S D	.....
Chemische Werke Huls	Marl	Polyethylene	6,000 tons/yr	.....	Planning	1960	Ziegler	Staff	Staff
Deutsche Erdoel	Heide	*Exp. Refinery	50,000 bbls	.....	Planning	1963	.....	.....	.....
Durag-Nerag	Misburg, Hannover	Platformer, Sulfur Recovery	4,500 bbls.	.....	Engineering	Sept 1960	UOP	Lurgi	Lurgi
		Delayed Coker	3,000 tons	.....	Under Constr	.....	.....	Lummus	Lummus
		Selective Cracker	21,000 bbls						
		Natural Gasoline Refinery with Crude Distiller	40,000 bbls	.....	Under Constr	.....	.....	Lummus	.....
Deutsche Shell	Harburg	Cat Reformer Hydrodesulfurization							
		Refinery	30,000 bbls	.....	Under Constr	1960	.....	.....	.....
	Godorf	Propylene Oxide	20,000 tons/yr	.....	Under Constr	1960	.....	Farbenfabriken Bayer	Farbenfabriken Bayer
Erdolchemie	Niederrhein	Ethylene	200,000 tons/yr	.....	Under Constr	1960	Farbenfabriken/ Bayer	S & W	S & W
		Ethanol	18,000 tons/yr	.....	Under Constr	1960	Shell	S & W	S & W
		Butadiene	30,000 tons/yr	.....	Engineering	Late 1960	.....	.....	.....
		Gasoline Selective Hydrogenation	90,000 tons/yr	.....	Under Constr	1960	BP	BP/Lurgi	Lurgi
Gewerkschaft Erdolraffinerie Emsland	Lingen Holthausen	Crude	32,000 bbls	.....	Under Constr	Early 1960	.....	Lurgi	Lurgi
		Unifiner-Platformer	4,700 bbls	.....	Planning	.....	UOP/ Shell	Lummus	Lummus
		Gas Oil Desulfurizer	5,500 bbls	.....	Planning	.....	UOP/ Shell	Lummus	Lummus
		Kerosine Desulfurization	270 tons	.....	Under Constr	Early 1960	.....	Lurgi	Lurgi
		Gasoline Desulfurization	207 tons	.....	Under Constr	Early 1960	.....	Lurgi	Lurgi

• First appearance in tabulation.

Construction BOXSCORE Continued on Page 236

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Frisia	Emden	Refinery	30,000 bbls	$17,000,000	Engineering	1960	.....	Parsons	Parsons
ali-Chemie	Bad Honningen	Hydrogen	.....	.....	.....	1960	Hercules	Power-Gas	Power-Gas
Purfina Mineralol-raffinerie	Duisburg	Topping, Platformer Hydro-desulfurizer	20,000 bbls	.....	Under Constr	1960	UOP, Shell	Lummus/Uhde	Lummus/Uhde
Rheinische Olefinwerke	Wesseling Bez., Kohn Koln	*Ethylene	75,000 tons	.....	Engineering	Early 1961	.....	Braun	.....
		Ethylene	.....	.....	Engineering	Jan. 1961	Kellogg	Braun/Lurgi	.....
Ruhrchemie	Oberhausen-Holten	Platformer	2,000 bbls	.....	Under Constr	Jan. 1960	UOP	Procon	Procon
		Unifiner	2,900 bbls	.....	Under Constr	Jan. 1960	UOP	Procon	Procon
		*Polyethylene	.....	.....	Under Constr	1960	Staff	Uhde	Staff/Uhde
Westdeutsch Erdolleitungs	Ruhlermoor	Crude Desalter	5,700 bbls	.....	Engineering	1960	Howe-Baker	Uhde	Uhde
GREECE									
Dow Chemical	.....	*Polystyrene Plastic	.....	$1,000,000	Planning	Early 1961	.....	.....	.....
Greek Government	Ptolemaeus, Greece	Ammonia	300 tons	.....	Engineering	Mid 1962	Uhde, Casale	Uhde, Casale	Uhde, Casale
		Ammonium Sulfate	525 tons						
		Ammonium Nitrate	325 tons						
IRELAND									
Irish Refining	Whitegate	Refinery	32,000 bbls	$33,600,000	Approved	1960	.....	.....	Lummus
Esso Petr. (Ireland)									
Caltex (Ireland)									
Shell Mex., B. P.									
ITALY									
Aziende Colori Nazionali Affini	Cengio	Phthalic Anhydride	22,000,000 lbs/yr	.....	Under Constr	Early 1960	Badger Mfg	Badger Mfg	Badger Mfg
Asfalti Bitumi Cementic Derivati, S.A.	Ragusa	Polyethylene	25 tons	.....	Under Constr	.....	.....	BASF	.....
Azienda Nazionale Idrogenazione Combustibil	Ravenna	Styrene Monomer	14,000 tons/yr	.....	Under Constr	.....	Koppers	SBA	SBA
		Butadiene	22,000 tons/yr	.....	Engineering	1960	Houdry	Catalytic	.....
		Ethylene	.....	.....	Under Constr	.....	Koppers	ANIC	.....
British Petroleum/ AGIP Mineraria	Venice	*Hydrofiner	6,500 bbls.	.....	Complete	.....	.....	.....	.....
Distilleria Italiana	Milan	Butanol	11,000 tons/yr	.....	Engineering	.....	Hoechst	Uhde	Uhde
Ftalital, S.p.a.	Italy	Maleic Anhydride	2,200,000 lb/yr	.....	Engineering	.....	S D	S D	.....
Italgas	Rome	High-Btu Oil Gas	1.8 MMcf	.....	Under Constr	1960	Semet Solvay	Power-Gas/ SAFII	Power-Gas/ SAFII
Mobil Oil Italiana	Naples	Cat Reforming	9,000 bbls	.....	Under Constr	.....	.....	CTIP	CTIP
		Cat Hydrodesulfurization	10,000 bbls	.....	Under Constr	.....	.....	CTIP	CTIP
		Lube Exp.	.....	.....	Under Constr	.....	.....	Staff	Staff
Montecatini Societe Generale per l'Industria Mineraria Chimica	Ferrara	Exp. Polypropylene	.....	.....	Planning	1960	.....	.....	.....
	Castellanza	Exp. Formaldehyde	135,000,000 lbs/yr	$300,000	Under Constr	.....	.....	.....	.....
	Brindisi	Petrochemical	700,000 tons/yr	$95,000,000	Under Constr	1962	.....	.....	.....
	Ferrara	*Ethylene	83 tons	.....	Complete	.....	.....	Kellogg	.....
Sincat	Priolio, Sicily	Ammonia	240 metric tons	.....	Complete	.....	Texaco	Foster Wheeler	.....
		Ethylene	.....	.....	Engineering	1960	S & W	S & W	.....
		Treating	.....	.....	Engineering	1960	.....	S & W	.....
Snia Viscosa	Varedo, near Milan	Carbon Disulfide	.....	.....	Under Constr	1960	Food	.....	.....
Wtanic Petrolifera	Livorno	Naphtha Stabiliser and Splitter	11,000 bbls	$720,000	Engineering	1960	.....	Esso	CTIP
Union Carbide Societa Edison S.A.	Sicily	Polyethylene	15,000 tons/yr	.....	Under Constr	1960	.....	.....	.....
	Celene	Ethylene Oxide	26,500,000 lbs/yr	.....	Under Constr	1960	.....	.....	.....
NETHERLANDS									
Kunstsijde Unie N.V.	.....	Styrene	.....	.....	.....	.....	rich	.....	.....
Esso Nederland	Rotterdam	Refinery	95,000 bbls	$50,000,000	Under Constr	Spring 1960	Esso	Esso	Badger N.V.
NORWAY									
Standard (N.J.)	Oslo Fjord	Refinery	40,000 bbls	$30,715,000	Engineering	Late 1960	Esso	Esso	Bechtel
PORTUGAL									
Ammoniaco Portugues	Esterreja.	Ammonium Sulfate	220 tons	.....	.....	.....	.....	.....	.....
Socedada Portuguesa de Petroquimica Sarl	Lisbon	Ammonia	185 tons	.....	Planning	.....	Uhde-Texaco	Uhde-STEC	Uhde-STEC
		Hydrogen	1.5 MMcf	.....	.....	.....	.....	.....	.....
		Fuel Gas	11 MMcf	.....	.....	.....	.....	.....	.....
RUMANIA									
Rumanian Govt.	Teleajen	Lube Oil	.....	.....	.....	.....	.....	.....	.....
		Natural Gas Treating	.....	.....	.....	.....	.....	.....	.....
	Borzesti	Petrochemical	.....	.....	.....	.....	.....	.....	.....
	Onesti	Synthetic Rubber	.....	.....	.....	.....	.....	.....	.....
SCOTLAND									
British Hydrocarbon Chemicals	Grangemouth	Polyethylene	25,000,000 lbs/yr	.....	Under Constr	1960	Phillips	S & W	S & W Ltd
		Ethylene	70,000 tons/yr	.....	Under Constr	Mid 1960	.....	S & W Ltd	S & W Ltd
		Cumene	.....	.....	Complete	.....	Mid-Centry	S D	S & W Ltd
		Phenol	.....	.....	Complete	.....	Distiller	S & W Ltd	S & W Ltd
		Gasoline Treater	.....	.....	Under Constr	Early 1960	BP	Lummus	Lummus
Union Carbide	Grangemouth	Polyethylene	30,000,000 lbs/yr	.....	Under Constr	.....	.....	.....	.....
SOUTH AFRICA									
AE & CI	Modderfontein	*Synthetic Ammonia	70,000 tons	.....	Under Constr	1960	.....	Staff/ICI/ Power-Gas	Power-Gas
Phillips Petroleum-Industrial Development		Carbon Black	22,000,000 lbs/yr	.....	Under Constr	.....	Staff	Staff	Staff
Standard Vacuum	Durban	Exp. Asphalt Oxidizer	2,100 bbls	$415,000	Under Constr	1960	.....	Staff	.....
			600 bbls						
SPAIN									
Repesa	Cartegena	Two Stage Crude	35,000 bbls	.....	Engineering	1960	.....	Foster Wheeler	Foster Wheeler
		*Fertilizer	.....	.....	Under Constr	.....	.....	Foster Wheeler	.....
SWEDEN									
A. Johnson & Co.	Sweden	Refinery Exp.	.....	.....	Under Constr	.....	.....	Bechtel	Bechtel
Stockholm Gas & Water Works	Stockholm	Cat Oil Gasification	4 MMcf	.....	Under Constr	1960	Power-Gas	.....	Power-Gas
SWITZERLAND									
Power-Gas	Winterthur	Catalytic Oil Gasification	606 Mcf	.....	Under Constr	.....	.....	Power-Gas Didier	Power-Gas Didier
TURKEY									
Badische Anilin and Soda Fabrik	Kutahya	Ammonium Sulfate	60,000 tons/yr	$20,000,000	Under Constr	.....	BASF	BASF	.....
		Sulfuric, Nitric Acid	50,000 tons/yr						
Mobil Oversea, Shell, Caltex BP	Istanbul	Refinery	65,000 bbls	$48,000,000	Under Constr	.....	.....	Foster Wheeler	Foster Wheeler
Turkish Government	Istanbul	Natural Gasoline	.....	.....	Planning	.....	.....	.....	.....
YOUGOSLAVIA									
Yougoslav Government	Sisak	Topping and Cat Reforming	15,000 bbls	$5,400,000	Planning	1963	.....	Inst. Pet., Zagreb	Staff
		Ammonia	120/tons	$11,000,000	Planning	1962	Foster Wheeler	.....	.....

* First appearance in tabulation.

Near East

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
ALGERIA									
Cie Francaire des Petrols	Algiers	.....	44,000 bbls	.....	Engineering	1962	.....	.....	.....
EGYPT									
Anglo-Egyptian Oilfields	Suez	Cat Reformer	2,300 bbls	.....	Projected	.....	.....	.....	.....
Egyptian Chem. Ind., KIMA S.A.E.	Aswan	Ammonia	415 tons	.....	Under Constr	1960	Uhde/BASF	Uhde/BASF	Uhde/BASF
Egyptian Govt.	Suez	Power	10,000 KW	$2,200,000	Planning	1960	.....	.....	.....
		Atmos. Distl., Vac. Distl. & Lube Oils	20,000 bbls	$7,000,000	Planning	1960	.....	.....	.....
		Cat Reformer	3,000 bbls	$2,700,000	Planning	1962	.....	.....	.....
		Hydrodesulfuriser	2,700 bbls	$720,000	Planning	1962	.....	.....	.....
		Lube Oils	.....	$9,000,000	Planning	1963	.....	.....	.....
	Alexandria	Atmos. & Vac., Distl.	10,000 bbls	$1,400,000	Planning	.....	.....	.....	.....
	Cairo	Atmos. Distl. & Vac., Distl.	10,000 bbls	$1,400,000	Planning	.....	.....	.....	.....
IRAN									
Iran Government	.....	Nitrogen	30,000 tons/yr	$30,000,000	Under Constr	.....	Montecatini	Foster Wheeler	.....
IRAQ									
Iraq Government	Baghdad	Refinery Exp.	48,000 bbls	$11,000,000	Under Constr	1960	Esso	Foster Wheeler	Foster Wheeler
		Powerformer	5,000 bbls	.....	.....	1960	.....	Foster Wheeler	Foster Wheeler
		Kerosine Treating	5,000 bbls	.....	.....	1960	.....	Foster Wheeler	Foster Wheeler
		Synthesis Gas	121 tons	.....	Under Constr	.....	.....	Foster Wheeler	.....
	Qaiyarah	Refinery Revamp Crude Topping; Vacuum Distl.; Thermal Cracking Asphalt	7,500 bbls	.....	Planning	1960	.....	.....	.....
Iraq	Kikuk	*Cold Crude Stabilizer	250,000 bbls	.....	Complete Under Constr	.....	.....	Foster Wheeler	Foster Wheeler
ISRAEL									
Fertilizers & Chemicals	Haifa Bay	Ammonia Exp. Fertilizers	50 tons	$5,000,000	Under Constr	1960	.....	.....	.....
MALTA									
Malta Gas Board	Valetta	Catalytic Oil Gasification	1 MMcf	.....	Under Constr	1960	.....	Power-Gas	Power-Gas
MOROCCO									
Ente Nazionale Idrocarburi	Mohammedia	*Refinery	25,000 bbls	.....	Under Constr	1962	.....	.....	.....
PAKISTAN									
Burmrah Oil, et al	Karachi	*Refinery	1,500,000 tons/yr	.....	Planning	.....	.....	.....	.....
Pakistan Industrial Dev.	Fruchanj, Pakistan	Ammonia	225 tons	$20,000,000	Engineering	1961	Kobe Steel	Chemico	Chemico
		Urea	375 tons						
SAUDI ARABIA									
Arabian American Oil	Ras Tanura	Alkylation	1,210 bbls	$6,990,000	Under Constr	1960	Kellogg	Kellogg/Staff	Staff
		LPG	1,500 bbls	$1,025,000	Engineering	1961	Kellogg	Staff	Staff
		*Asphalts	.....	.....	Under Constr	.....	.....	.....	.....
SYRIA									
Syrian Government	Homs	Refinery	20,000 bbls	$14,000,000	Planning	1960	Technoexport Prague	Technoexport Prague	Technoexport Prague

Far East

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
HONG KONG									
Hong Kong & China Gas	Hong Kong	Cat Oil Gasification	1.5 MMcf	.....	Under Constr	1960	.....	Power Gas	Power Gas
INDIA									
Indian Government	Assam	Refinery	15,000 bbls	$17,000,000	Planning	.....	.....	Rumanian Government	Rumanian Government
	Barauni	*Refinery	40,000 bbls	.....	Planned	.....	.....	.....	.....
National Carbon	Bombay	Polyethylene	.....	.....	Under Constr	Mid 1960	.....	B & R	B & R
Sahu Chemicals	Varanasi	Ammonium Chloride	120 tons	.....	Under Constr	1960	Uhde	Uhde	Uhde
		Soda Ash Fertilizer	120 tons	.....	Under Constr	1960	Pintsch/Bamag	Pintsch/Bamag	Pintsch/Bamag
		Ammonia	120 tons	.....	Under Constr	1960	John Thompson	CECIP	John Thompson
Standard Vacuum	Bombay	Asphalt	125,000 tons/yr	$2,500,000	Under Constr	1960	.....	Parsons	Parsons
INDONESIA									
Indonesian Government	Palembang, Sumatra	Urea Fertilizer	330 tons	.....	Under Constr	.....	.....	Foster Wheeler	Foster Wheeler
JAPAN									
Asahi-Dow	Kawasaki	Styrene Monomer	50 metric tons	$4,150,000	Under Constr	1960	Dow	Dow	Dow
Asahi Chemical Industries	Nobeoka	NH_3 Synthesis Gas	50 metric tons	$3,670,000	Under Constr	1960	Texaco/Chemico	Chemico	Chemico
Daikyo Oil	Yokkaichi	Topping & Vacuum	30,000 bbls	.....	Under Constr	1960	.....	J G C	J G C
Furukawa Chemical Industries	Japan	Polyethylene	20,000,000 lbs/yr	.....	Complete	.....	Standard (Ind.)	.....	.....
		Platforming	5,000 bbls	.....	Planning	Mid 1960	UOP	UOP/JGC	.....
Japan Synthetic Rubber	Yokkaichi	Butadiene & GR-S Rubber	45,000 tons/yr	$30,000,000	Under Constr	1960	Houdry Esso Goodyear	Blaw-Knox; Catalytic; Chiyoda	Chiyoda
Koa Oil	Iwakuni	F C C	5,500 bbls	.....	Under Constr	Early 1960	UOP	UOP/JGC	.....
		Delayed Coker	4,500 bbls	.....	Planning	1960	UOP	UOP/JGC	.....
		Vacuum Distl.	8,400 bbls	.....	Under Constr	1960	UOP	JGC	.....
Kyowa Fermentation Industry Co., Ltd.	.....	Acetaldehyde	45 tons	.....	Planning	.....	Knapsack-Grieshelm	Uhde	Uhde
	Ube	Butanol, Octanol, Acetylene, Ethylene	.....	$13,500,000 $6,500,000	Planning Planning	....	....	Ilon-Tears	Ilon-Tears .....

* First appearance in tabulation

Construction BOXSCORE Continued on Page 238

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Marusen Oil	Matsuyama	Udex	1,500 bbls	$2,200,000	Under Constr		UOP	UOP; J G C	J G C
		Benzene	6,600 tons/yr		Under Constr		UOP		
		Toluene	4,000 tons/yr		Under Constr		UOP		
		Xylene	4,000 tons/yr		Under Constr		UOP		
		Oxidation:	20 tons						
		Benzoic Acid	900 tons/yr						
		Phthalic Acid Anhydride	2,245 tons/yr	$4,000,000	Complete		S D	S D	S D
		Isophthalic Acid	5,600 tons/yr						
		Terephthalic Acid	2,500 tons/yr						
		Crude Topping	25,000 bbls	$1,400,000	Complete			Chiyoda	Chiyoda
Mitsui Petrochemical Industries	Iwakuni City	Terephthalic Acid			Under Constr	1960	S D	S D	Mitsui Shipbuilding
		Paraxylene			Engineering	1960	S D	S D	
		Cat Reformer			Engineering				
		Paraxylene				1960		S D	
Nippon Petrochemicals	Kawasaki	Ethylene	25,000 tons/yr	$16,000,000	Complete	1960	S&W	S&W; J G C	S&W; J G C
		Butadiene	6,000 tons/yr						
		*Alkyl Benzene	15,000 tons	$4,000,000	Planning	June 1961	Cal Research		
		*Isopropanol	6,000 tons/yr	$2,500,000	Planning	Dec 1960	Distiller		
		*Acetone	6,000 tons/yr						
Nilto Chemical Industry		Synthesis Gas	125 tons	$6,000,000	Planning		Texaco	Iino-Tears	Iino-Tears
SBA & Sumitomo Chemical	Niihama City	Acetylene-Ethylene			Planning			Staff	Staff
Showa Denko KK	Tokyo	Synthesis Gas	121 short tons		Under Constr	1960	Texaco	Foster Wheeler	Foster Wheeler
Showa Yuka	Japan	Polyethylene			Complete		Phillips	Staff/Braun	
Toa Nenryo Kogyo	Shimizu	Exp. Powerformer; Hydrofiner; Kerosine Acid treating; Copper Sweetener; Offsite Facilities	43,500 bbls	$12,500,000	Under Constr				
Ube Kosan		Ammonia	100 tons/day		Engineering	Jan. 1960		Chemico	Chemico
KOREA									
Korean Government	Chung-ju	Urea	270 tons	$33,500,000	Under Constr		Inventa-Vulcan	Hydrocarbon, McGraw Vulcan	Hydrocarbon McGraw
	Naju	Urea	95,000 tons/yr		Engineering	1962	Inventa	Lurgi/Uhde	Lurgi/Uhde
Korea Petroleum	Ilsan	Refinery	20,000 bbls		Planning				
TAIWAN									
Thai Defense Ministry	Bangkok	Refinery	5,000 bbls	$20,000,000				Japanese Fuji	Japanese Fuji

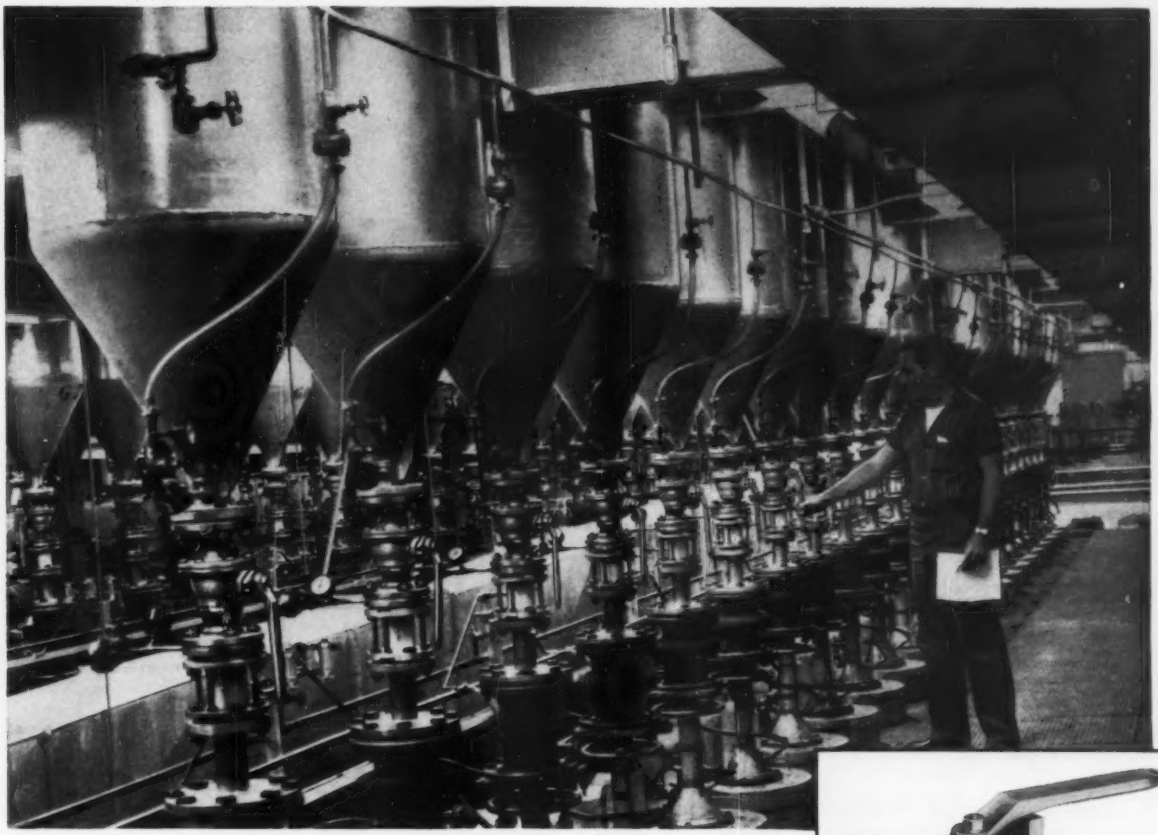
Australasia

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
AUSTRALIA									
Australian Oil Refining	Kurnell	Exp. Refinery:				1961	UOP/ Kellogg	Kellogg	
		Crude	45,000 bbls						
		FCCU	18,000 bbls						
		Alkylation	3,400 bbls						
Australian Synthetic Rubber	Altona	*Synthetic Rubber		$10,000,000	Under Constr	1961		Fluor	Fluor
Bitumen & Oil Refineries	Sydney	Diesel Unifiner	2,500 bbls		Under Constr			UOP	Staff
		Crude	12,000 bbls		Planning			Procon	Procon
CSRC Dow Pty	Altona	Styrene			Under Constr	July 1961			Bechtel/McDonald/Wimpey & Coy
Imperial Chemical Industries of Australia & New Zealand	Australia	Polyethylene	5,000 tons/yr	$5,040,000	Under Constr				
Shell Oil	Newport	Oil Blending							
Shell Refining (Australia)	Clyde	Platformer	6,700 bbls		Under Constr		UOP		Procon
	Geelong	Hydrodesulfuriser	11,000 bbls		Planning	1960			
		Detergent Alkylate			Under Constr			Foster Wheeler	
Standard Vacuum	Adelaide	Refinery	30,000 bbls	$30,000,000	Planning				
	Altona	Petrochemicals (Ethylene & Butadiene)	20,000 tons/yr	$28,000,000	Engineering	Winter 1961		Fluor	Utah-Australia
		Sovafiner			Complete				
		Sulfur Recovery			Complete				
Shell Chemical	Clyde	Resins, Alkylates		$22,000,000	Planning				
PHILIPPINE ISLANDS									
Filoil Refining	Luzon	Refinery	10,000 bbls		Planning	Late 1960			
Shell (Philippines)	Manila	Refinery			Planning				
Standard Vacuum	Bataan	Refinery	25,250 bbls	$35,000,000	Engineering	Late 1960		Foster Wheeler	Foster Wheeler
Union Carbide	Melbourne	Polyethylene	15,000,000 lbs/yr		Planning	1961			

* First appearance in tabulation.

Atlantic—Atlantic Ref. Co.
Austin—The Austin Co.
Badger France—Badger Ltd.
Badger N. V.—Badger N. V., Netherlands
Badger Mfg.—Badger Mfg. Co.
B & R—Brown & Root, Inc.
BASF—Badische Anilin & Sod. Fab.
Bechtel—Bechtel Corp.
Blaw-Knox—Blaw-Knox Co.
Braun—C F Braun Co.
Calif. Res.—California Research Corp.
Canadian Badger—Canadian Badger Company Limited
Canadian Bechtel—Canadian Bechtel Limited
Catalytic—Catalytic Construction Co.
Chemical Projects Assoc.
Chemico—Chemical Construction Co.
CTIP—Compagnia Technica Industria Petroli
Dresser—Dresser Engineering Corp.
Ehrhart—Ehrhart & Associates, Inc.
Esso—Esso Research and Engineering Co.
Ferguson—H. K. Ferguson Co.
Fluor—Fluor Corp.
Food—Food Machinery & Chem. Corp.
Foster Wheeler—Foster Wheeler Corp.
Girdler—Girdler Construction Division, Chemetron Corp.
H & G—Humphrey & Glasgow
Hudson—Hudson Engineering Corp.
Hydrocarbon—Hydrocarbon Research, Inc.
HWP—Head Wrightson Process, Ltd.
ICI—Imperial Chemicals, Inc.
JGC—Japan Gasoline Co.
Kellogg—The M. W. Kellogg Co.
Kidde Constr.—Walter Kidde Constructors, Inc.
Kidde Engrs.—Walter Kidde Engineers Southwest, Inc.
Koppers—Koppers Co., Inc.
Leonard—Leonard Construction Co.
Litwin—Litwin Engineering Co.
Lummus—The Lummus Co.
Lurgi—Lurgi G. m. b. H.
Macco—Macco Corp.
McKee—Arthur G. McKee Co.
Nofsinger—The C. W. Nofsinger Co.
Olsen—O. L. Olsen Co.
Parsons—The Ralph M. Parsons Co.
Power Gas—Power Gas Corp., Ltd.
Pritchard—J. F. Pritchard Co.
Procon—Procon, Inc.
Quaker—Quaker Valley Constructors
S&W—Stone & Webster Engineering Corp., Chemical Division
S&W Ltd.—Stone & Webster Canada, Ltd.
SBA—Soc. Belge de L'Azote et des Produits Chimiques du Marly
SD—Scientific Design
SFST—Societe Francais des Services Techniques
Soc. Chimique—Societe Chimique de la Grande Paroisse
Stearns-Roger—Stearns-Roger Mfg. Co.
Sumner Sollitt—Sumner Sollit Co.
Sweco—Southwestern Engineering Co.
Tellepsen—Tellepsen Petro-Chem Constructors
Treco—Refinery Engineering Co.
Uhde—Friedrich Uhde, G. m. b. H.
U.O.P.—Universal Oil Products Co.
Vulcan—Vulcan Cincinnati, Inc.

They broke up the pellet traffic jam...



with Rockwood Ball Valves

A costly and recurrent problem in a large southern synthetic fibre mill was the jamming of polymer pellets as they came from supply hoppers. Source of the trouble was the tapered-throat design of the valves. Even with valves fully open, pellets piled up. In addition, this packing-in action caused severe abrasion on the valves. The problem was solved by replacement with Rockwood Ball Valves. Their *straight-through-opening* feature now permits pellet to flow smoothly . . . and the wear problem has been automatically eliminated because Rockwood valves offer no more resistance to flow than the pipeline itself.

What's more, after hundreds of openings and closings Rockwood Ball Valves still provide *positive leak-proof* shut-off means. A retainer spring, which *automatically compensates for pressure variations* keeps the seat snug against the ball and holds tight even under vacuum.

Thousands of Rockwood Ball Valves are giving efficient service and cutting costs throughout industry — in oil refineries, textile mills, paper, chemical and rubber plants.

There are types and sizes to meet every requirement in *your* plant. Write today for the illustrated folder on Rockwood Ball Valves. Tested and listed by Underwriters' Laboratories, Inc. Rockwood Sprinkler Company, A Division of The Gamewell Company, 247 Harlow Street, Worcester 5, Mass. Distributors in principal industrial areas.

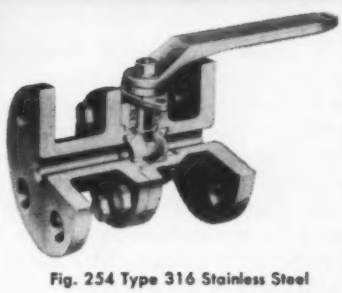


Fig. 254 Type 316 Stainless Steel

Rockwood Ball Valves are available in pipe sizes ⅜" through 16" in screwed ends 150 lb. and 300 lb. flanges. All internal parts are of Type 316 stainless steel with spring-compensated TEFLON* seats. Recommended for 600 p.s.i. working pressure and suitable for temperatures ranging from—100° F. to 400° F. All sizes are available with two retainer springs and two Teflon seats.

*DuPont Reg. T. M.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

LUMMUS ENGINEERS, CONSTRUCTS NEW 31,500 BARREL PER DAY REFINERY FOR ESSO STANDARD S.A.F. AT BORDEAUX

When Lummus completed construction this spring of Esso Standard's new Bordeaux refinery, it added 31,500 barrels per calendar day to France's refining capacity. The new Bordeaux installation is also the first refinery designed and built to operate on French crude. Crude flows through a 12" pipeline from Esso-REP's Parentis field south of Bordeaux.

In recent years *existing* refineries in France have expanded greatly. The new Bordeaux refinery, on the other hand, is a "grass roots" refinery – the second built in France since World War II–and Lummus has handled the engineering and construction of both.

Although the refinery will operate at 31,500 barrels per day initially, facilities are designed to permit expansion to a 45,800 B/D throughput at minimum cost.

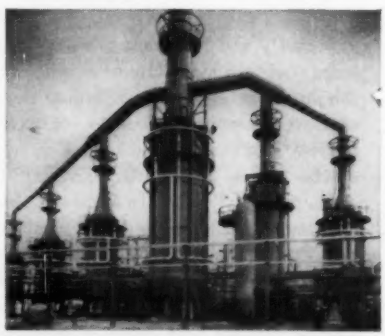
The refinery's design permits production of LPG, motor gasolines, jet fuels, kerosene, diesel fuels, heating oils, light and heavy fuel oil, and asphalts. Automatic blending equipment has been included to produce the various grades of asphalt required for the French market.

The Bordeaux refinery uses Esso Research and Engineering's "Hydro-Skimming" processing plan, which consists of atmospheric and vacuum distillation, with Hydrofining and Powerforming to produce the required gasolines. Light ends and treating sections are also included for both the pipestill and Powerformer.

In addition to product shipping facilities, Lummus also provided complete auxiliary and off-site facilities, including storage tanks, steam generation, cooling water, electric power, and air – plus the necessary piping, transfer pumping and TEL blending.

The Bordeaux project was handled by Lummus' French company, Societé Française des Techniques Lummus, with specialists from Lummus in the United States teaming up with those from Paris.

For design, engineering and construction of refineries anywhere in the world, contact one of the eight Lummus offices – and draw on more than 50 years' experience on over 800 major installations.



On the unusual heater exhaust system shown above, all vertical heaters exhaust into diagonal flues which feed one central stack.

LUMMUS

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The Growing Problem of Labor Monopoly

Unions became exempt from anti-trust legislation in 1914. Since then, they have been permitted to grow and combine until today they constitute the most flagrant example of monopoly control this nation has ever witnessed

E. F. Scoutten
The Maytag Company, Newton, Iowa

THE RECENT enactment by the Federal Congress of the Labor-Management Reporting & Disclosure Act of 1959 (Landrum-Griffin Bill) has produced a variety of reactions among labor, management, and the general public.

There are those in the labor movement who condemn this law as being an unwarranted invasion, by government, of what they regard as the private business of labor unions. It has been suggested by some union leaders that this law places an unwarranted burden upon labor unions, and that there was neither a justification nor a need for it.

Many labor leaders, of course, recognize that this law is intended, essentially, merely to prevent abuses by unscrupulous union leaders of basic rights and freedoms of American workers. Probably, the vast majority of workers, to the extent that they understand this new law, would agree that it was needed and that it will work no hardship on any legitimate, honest, and decent labor union or labor leader.

No Panacea. It is probably safe to say that the vast majority of the general public has concluded that with the enactment of this law, problems in the field of labor-management relations have now been satisfactorily disposed of for at least a lengthy period, if not forever. Representatives of both labor and management, who are understandably better acquainted with the problems in this area, know that this law has in no way resolved many of the basic issues which have for the last 25 years plagued our economy.

The vast majority of management personnel would probably concur that the new labor law has helped correct basic injustices which have existed in the labor movement, and that the law was by all means a much needed step in the right direction. Most of these management people, however, would go further and note that there are still significant problems requiring the attention of Congress and that until Congress takes corrective action, these basic problems will continue to gnaw at the vitals of our national economy.

The most significant of these basic problems is probably that represented by the existence of vast union monopolies.

In 1890, Congress enacted the Sherman Anti-Trust Act which, in simple, straightforward language, provided that "every contract . . . in restraint of trade or commerce among the several states . . . shall be

Powerful labor leaders can require American Workman to take membership in, and pay tribute to a political organization known as a labor union, as a condition of earning their living. Thus these unions are able to wield powers denied to any other organizations in our economy—even our federal government.

illegal." The Act also provided that any attempt by any person to "monopolize . . . or combine with any other person or persons to monopolize any part of the trade or commerce among several states . . . " shall be punished as a misdemeanor, with a fine of as much as $50,000.

The Sherman Act, while it has been amended several times, continues to stand as the keystone in the entire structure of anti-trust legislation which Congress has enacted during the ensuing years.

Labor Exempt. In 1914, however, the Congress passed into law, the Clayton Act which, in Section 6, specifies "the labor of a human being is not a commodity or article of commerce. Nothing contained in the anti-trust laws shall be construed to forbid the existence of labor . . . organizations instituted for the purpose of mutual help."

The net result, of course, has been that during the 45 years since passage of the Clayton Act, labor unions have been specifically exempted from the anti-trust legislation. They have been permitted to grow and combine, until today they constitute the most flagrant example of monopoly control that this nation has ever witnessed. While representatives of the Department of Justice religiously ferret out, investigate, and prosecute any attempt of any employer to merge, combine, or otherwise strengthen his competitive position, if such maneuver tended even slightly toward monopoly, the labor unions, being free of such restrictions, have continued to merge, combine, and thereby increase their economic strength, without limit and without question.

Please note that it is not the intention of this article to suggest in any way, directly or indirectly, that there is anything basically objectionable about labor unions, or that they should, by any device, be prohibited or limited in legitimate activities for their members. I happen to believe that the existence and growth of labor unions in this country has served many worthwhile and desirable purposes. The impact of labor unions on our industrial economy has been invaluable in improving the quality and techniques of our entire industrial system. Like any other entity, however, it is possible to "have too much of a good thing." It is the purpose of this article to suggest that our economy and our nation have long since been suffering from too much unrestricted labor union monopoly power.

No Commodity. Section 6 of the Clayton Act predicates its exemption of labor organizations upon the assumption that "labor of a human being is not a commodity." I think it is important that we should examine this assumption; and I suggest that labor is, in fact, a commodity. It always has been one, and it always will be one, in spite of the pious pronouncements of fuzzy-thinking liberals to the contrary.

To allege that labor is a commodity does not imply, as some of my friends in the labor movement have charged, that you stack men on the shipping dock like sacks of wheat. Neither does it suggest that you treat them in any fashion not proper and fitting for the treatment of human beings.

If labor is defined as the physical effort, mental know-how, technological and managerial skills of men, then labor is a commodity because essentially, labor is our only commodity. Basically, we have nothing to sell except labor. Labor behaves precisely like all other commodities in the market. It is subject to the law of supply and demand, and may be made available or withheld; may be bargained for; and may be purchased or rejected by the consumer. It must meet competition, both as to price and as to quality and, in short, must meet the same market tests of any other commodity.

The fact that we have in our law, provisions such as the Minimum Wage, the Workmen's Compensation statutes, the Unemployment Compensation Laws, and all the many other regulations of conditions of work with respect to safety and health, for example, does not in any way change the fact that the labor of human beings is a commodity.

The Price We Pay. If you will examine critically, an automobile, a washing machine, a heat exchanger, clothing, food, or any other commodity you care to mention, you will discover that, essentially, the price which you pay for that product is a payment for labor. The mining of iron ore is a labor cost. The transportation of the ore to the steel mill is a labor cost. The processing of the ore into steel is a labor cost. The cumulative cost of all the other elements which go into the production of a finished sheet of steel are likewise labor costs.

The price which the automobile manufacturer pays for his steel is a labor cost. When that steel, after modification and further work has been done upon it, appears as a part of your new automobile, it appears, essentially, as a labor cost. Likewise, all the other elements and parts of the automobile, traced back to their ultimate source, are essentially nothing but labor costs. To say that labor is not a commodity is to deny the facts of life. Basically, labor, in its broadest sense, is our only commodity.

It is true, of course, that wrapped into all these component costs are literally thousands of tax levies, and these tax costs are part of the cost of the finished product. Also wrapped into these costs are profits which are exacted at many points in payment for use of capital. There are no other elements to costs. The vast majority of the cost of any item you care to mention is the cost of human labor.

Monopoly Control. Whenever the laws of this country permit a monopoly control over the major cost element of everything which the American people consume, it seems evident that the attention of the Congress should be focused on that monopoly condition. It even seems more evident:

Whenever a handful of labor leaders can shut down 87 percent of our basic steel industry, or 100 percent of our automobile industry. Here we are faced with a monopoly control which is denied to any employer, and which, in fact, is denied to the federal government, itself.

When powerful labor leaders can require American workmen to take membership in, and pay tribute to a political organization known as a labor union as a condition of earning a living. Thus we are faced with powers denied to any other organization in our economy, and which, again, are denied to our federal government.

When powerful individual labor

leaders can defy Congress and have the audacity to issue threatening letters on a wholesale basis to members of the Congress. It would seem that the Congress ought to enact legislation to restrict this unwarranted monopoly power.

When powerful national unions exact "voluntary contributions" from millions of workers, to be fed into the coffers of favored political candidates. Such contributions are denied as a political tool to be used by corporations or employers, and thus we have created a Frankenstein monster which should cause the people in this country very grave concern.

When a powerful international union, such as the United Automobile Workers, can assess several hundred thousand workers at General Motors, a substantial and continuing monthly payment to create and maintain a multi-million dollar strike fund, which it may use to finance strike activity against any one of General Motor's competitors. Here we witness the most flagrant use of monopoly power that can be imagined in the control, and in the abolition, of interstate commerce.

The Solution. I have heard presumably learned and sophisticated experts in the field of anti-trust legislation imply that there is no practical means available for limiting such union monopoly power. I suggest that the means and techniques are readily available and are ridiculously simple.

If Congress will repeal Section 6 of the Clayton Act, and provide in its place a simple statement prohibiting any one labor organization from representing the employes of more than one employer, except where such employer voluntarily agrees to such multiple representation, the problem will be solved completely and forever.

This would mean, of course, that if the United Automobile Workers wish to represent the employes of General Motors, and the employes are willing to have them do so, they could proceed, as a union, to serve the General Motors employes. They could negotiate with General motors precisely as has been long since established under applicable Federal statutes. Furthermore, if this same Union wished to represent the employes of the Ford Motor Co., and the employes were willing to permit it, it could serve in the same capacity with respect to the Ford Motor Co. This is provided, of course, that the Ford Motor Co. agrees to have its employes represented by a union simultaneously representing General Motors employes. If Ford would not agree to this, it could demand individual representation.

Employer Rights. Such a provision of the law would permit multiple bargaining by small groups of employers with a single union representing employes of each member employer. It would also guarantee the right, however, to any employer to refuse to participate, if he chose, in such multiple bargaining, and to insist that the union representing his employes be an individual union to bargain with him as an individual employer.

In short, such a provision would apply to labor unions precisely the same rules of anti-monopoly control which have for many years applied to corporations. If two corporations decide to merge, and thereby improve their competitive position, and such merger is frowned upon by the Department of Justice, the merger is almost automatically prevented. A recent example of the proposed merger of Bethlehem and Youngstown in the steel industry and of Texaco and Superior in the oil industry are illustrative of the point: if the employers are permitted to merge, the unions would be permitted to merge. How illogical can we be, to forbid the merger of Bethlehem and Youngstown, but simultaneously to permit a single union to dictate identical wage rates and conditions of employment to not only both of these companies, but to 87 per cent of the steel industry in general?

Such a modification of our anti-trust legislation would obviously put an end to future national emergencies, which otherwise will arise in the striking of an entire steel industry, automobile industry, or in the shutting down of every port of entry on our eastern and southern coasts.

Equal Strength. Why should we expect management representatives to maintain our free enterprise economic system in the face of union monopoly power, making it literally impossible to resist successfully any socialistic or other demand which a handful of national labor leaders may choose to make? Why should we not continue to guarantee the right of American workers to bargain collectively but, at the same time, limit the combination of such bargaining groups to a size at least roughly comparable to the employer with whom they negotiate.

If we essentially limit union control to employes of the employer with whom they negotiate, we will at least have made the rules reasonably fair to both parties concerned. Under our present rules, we insist that a flyweight corporation enter the arena with a heavyweight union. Then, we are amazed because such unions are able to impose restrictions upon our economy which feed inflation, deteriorate basic principles of our free enterprise system, and gradually stifle our industries by making us non-competitive in the world markets.

Such a simple modification of our laws, will increase productivity, competition, and national progress.##

About the Author

E. P. Scoutten is presently vice president, personnel, for The Maytag Co., Newton, Ia., where he is responsible for all phases of Industrial Relations and personnel programs. This includes contract negotiations, wage and salary administration, safety and plant protection, employment and employe welfare. Scoutten received his B.S. degree in chemistry from Kent State University in 1931, and his B.S. degree in education from Kent one year later. Then in 1937 he received his M.A. degree and in 1942 his Ph.D. degree, both from Ohio State University. He also was graduated from Harvard Business School in 1957. From 1942 to 1949, Scoutten was supervisor of industrial relations in several U.S. Rubber Company plants, then in 1949 he joined the Houdaille-Hershey Corp., Detroit as assistant director of industrial relations. He remained at that post until 1952 when he joined The Maytag Co. as director of industrial relations. He was made a vice president in 1956.

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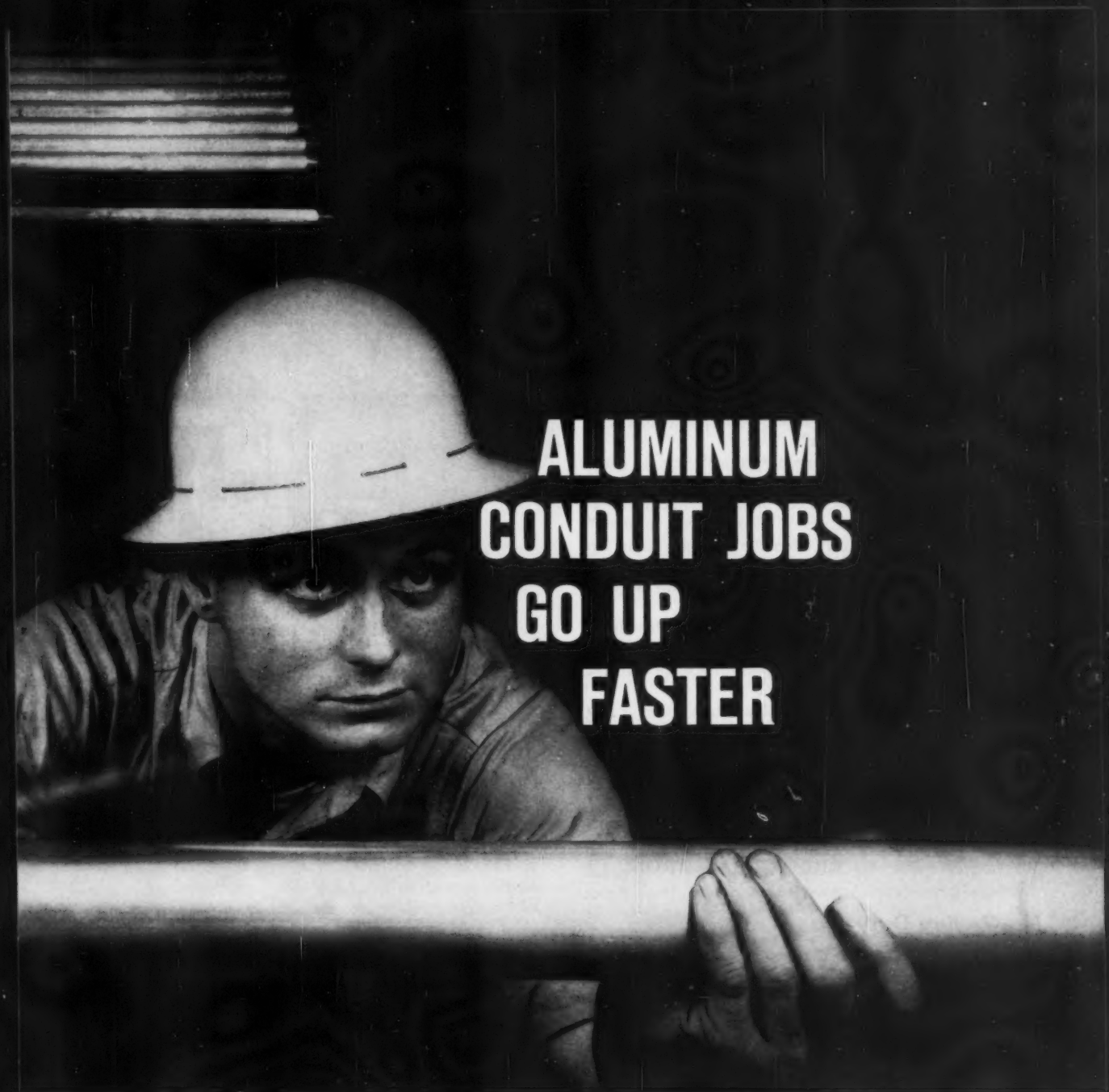

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Test Yourself on Labor Relations

No. 1. Smoke Discipline

The company had a written rule which read "No smoking is permitted in or around the plant except in specifically designated places."

Price and Cothran, two employes with several years seniority were caught smoking on the roof. They were given a disciplinary layoff. They protested that the company was unjust because there were no "no smoking" signs in that area. At arbitration the company came up with both barrels:

1. We have a written rule and every employe is given a copy when hired.
2. These two men knew that rule because they have worked here for several years and heard foremen warn men against smoking anywhere except the rest rooms.
3. We have had several fires and we aren't taking any more chances.
4. We don't have to post rules to have them obeyed. We did it orally and that's enough. If we posted "no smoking" rules, we'd have to plaster the whole plant with signs.

Test Yourself:

Was the company RIGHT ☐ WRONG ☐

No. 2. Jury Duty

Arthur Patchin worked the second shift which started at 4:00 p.m. He was called for jury duty and served for 6 days during which time he did not show up for work.

When the week was up, Patchin presented the company with a check for $36.00 which he had received for jury duty. He asked that the company make up the difference between his regular pay and the jury pay. The company did have a policy of making up such differences. But in Patchin's case, it refused. It maintained that he could have come to work because on all of those 6 days, court let out early enough for Patchin to have worked part or all of his shift.

Patchin admitted that he got out early, but he still wanted his money.

Test Yourself:

Was Patchin RIGHT ☐ WRONG ☐

No. 3. Company Personnel Records

The company had a long-standing policy of giving carbon copies of warning notices to the employes involved and to the union. This procedure was spelled out in the union agreement.

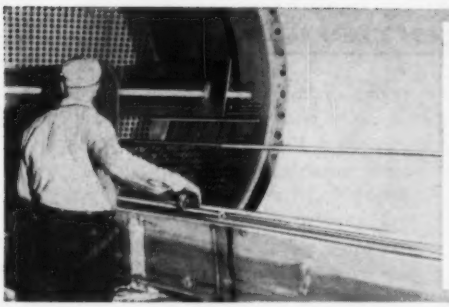
In order to improve its record keeping, the company devised a new form. It was called "Employe Performance and Conduct Form." This form was to be used by supervisors as a way to rate employes. The union maintained that it had a right to inspect these forms because if they contain any criticism of the worker, then in effect, this record amounts to a "warning slip."

The company answered that this would not be done. It said that management has a right to get up any records it wants, and neither the union nor the worker can poke around the files. The issue came to arbitration.

Test Yourself:

Was the company RIGHT ☐ WRONG ☐

Answers on Page 254



CONDENSER AND HEAT EXCHANGER CLINIC

Edited by A. W. Tracy, Metallurgical Engineer
The American Brass Company, Waterbury, Conn.

OPERATING FACTORS THAT AFFECT CONDENSER TUBE LIFE

Answers to some of the questions sent in following a previous clinic on this subject

Q. How effective is chlorination as a preventive maintenance procedure in cleaning tubes fouled by polluted water?

A. The chlorination of polluted sea water has been found to be effective in removing or preventing the formation of slimes on the walls of tubes. Better cleanliness was indicated by higher vacuum obtained on the steam side of the condenser. Tubes kept clean by chlorination have been reported to be less subject to pitting. It should be interjected here that tubes carrying polluted sea water containing sulfides from decomposition of organic matter seldom undergo inlet end corrosion, but the remainder of the length of the tubes often becomes pitted. Clean sea water, if entering the tube turbulently, will often cause corrosion at the inlet end, and usually the remainder of the length of the tube is coated with a good protective film of corrosion products.

The statement that chlorination may break down sulfide films on the walls of tubes is based on the fact that chlorine is an oxidizing agent and would oxidize sulfides; however, it is realized that the usual chlorine treatment would probably not remove thick long-standing sulfide scales.

Q. How often should tubes be cleaned and what are some of the methods used?

A. The required frequency of tube cleaning depends, of course, on how rapidly the tubes become fouled. In some power plants, tubes are cleaned once a week; at other stations, cleaning is required only at intervals of several months. Often the decision to clean tubes is determined by the drop in vacuum on the steam side.

In regard to methods for removing accumulations from condenser tubes, some station operators shoot rubber plugs through the tubes; others use bristle brushes, either of animal hair or nylon. The use of brushes is reported by some to do a better job of cleaning than the use of plugs.

An interesting method for continuously cleaning condenser tubes has been developed in Europe. A large number of sponge rubber balls, slightly larger in diameter than the inner diameter of the tubes and having about the same specific gravity as sea water, is fed continuously into the inlet water box. The cooling water forces the balls through the tubes, and deposits on the tube walls are swept away. The balls are collected by a cone in the outlet water box. They leave the water box through a tube connected to the end of the cone and are recirculated into the inlet water box. By the law of probability, each tube will eventually receive a ball. The system is not applicable to tubes that have been in service and have become rough and pitted.

Some stations periodically remove deposits from tubes by recirculating a dilute, inhibited hydrochloric acid solution through the condenser.

Q. How important are temperature and velocity as factors in the service life of condenser tubes?

A. Corrosion of condenser tubes is usually more rapid in summer than in the winter, but pollution due to bacterial action in the summer may be a more important factor than temperature itself. Instances have been observed where failures in a set of tubes occurred only in the warm-water months and none in the cold-water months, over a period of several years.

Mention was made in the clinic to the effect that high temperature of water causes pitting, due to the formation of gas bubbles on the tube wall. This type of pitting occurs most frequently, but not often, in oil refinery condensers where temperatures on the vapor side may be as high as 350F and water velocities relatively low. In a power plant condenser, temperatures on the vapor side ordinarily do not exceed 100F and temperature rise in the cooling water from the inlet to the outlet end is usually limited to 10F.

TECHNICAL ASSISTANCE. Our Metallurgical Department is regularly helping manufacturers, electric power companies, marine operators, petroleum and chemical companies to select the correct tube alloy for many types of condensers and heat exchangers. This service is available to you without obligation. Write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 5961

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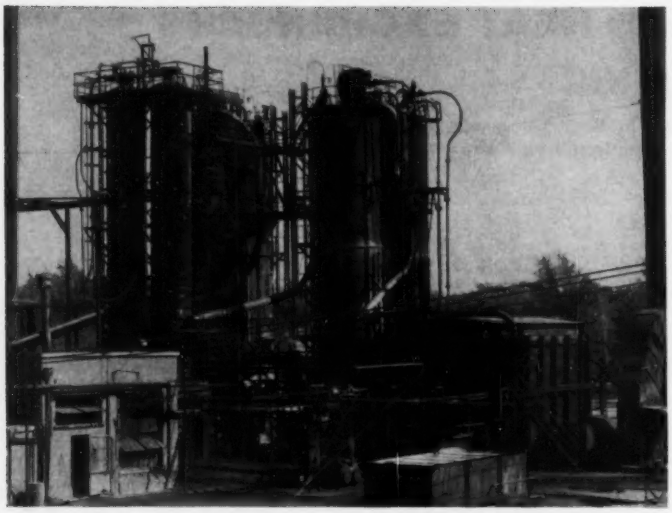
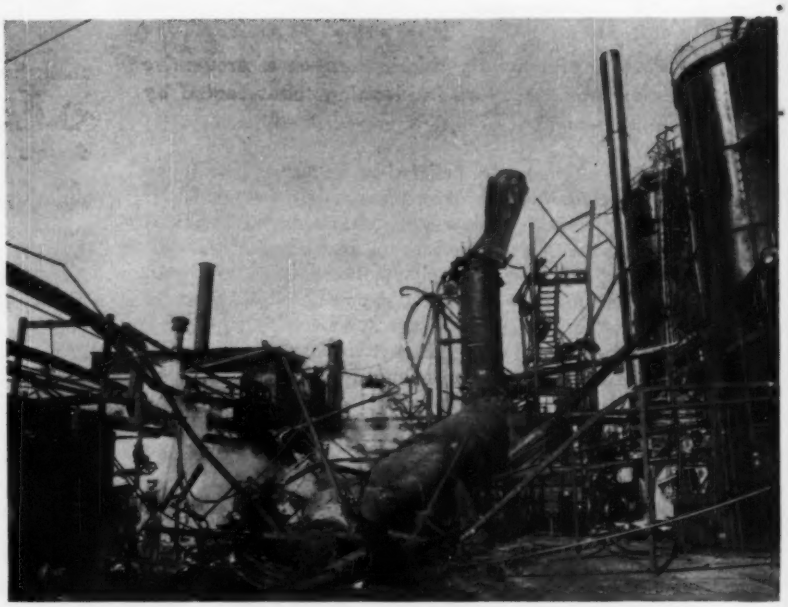


Old Units Do Explode!

BEFORE FIGURE 1—Standing side-by-side, these two Dubbs units had come onstream more than 6,000 times.

Here's the full story of the explosion that rocked the refinery of Cities Service last January. Who would have thought that such a potential hazard existed in a coking process operating for more than 30 years?



AFTER FIGURE 2—A series of human errors resulted in an explosion equal to 800 pounds of solid explosive.

O. A. Pipkin
Cities Service Oil Company
Ponca City, Okla.

OLE NO. 1 Dubbs had made her last run, but we didn't know this until later. It was one of those cold January days we sometimes have in Oklahoma. Temperatures had remained below freezing all day, and readings below 10° F were forecast for the night.

The coke-out men were having good luck cleaning the "still." Coke consistency was good, and the cable was pulling well. There was just one hitch. As will sometimes happen, the operators the night before, when "watering down" the chambers, had floated some tar into the dephlegmator. This meant extra work and longer hours for some of the coke-out men. Appreciating the fact that it was cold, and a still is worth just so much money to them since they have a special contract as to rate of pay for each still, you can understand why some of the things the men had to say about the operators were not too complimentary. Nevertheless, they did their usual good job and were able to turn the unit over to the operators approximately five hours behind normal schedule.

Five hours behind schedule is not so very long, but it meant that the

evening operator would be lining up the unit after dark.

Experienced Men. You cannot help but feel just a little more comfortable when experienced operators are bringing a unit onstream. This was the case that evening. Temporary shutdown of the thermal cracker had "bumped" some of the more experienced coker operators back to that classification. Both the evening and "hoot" shift operators were experienced men.

The duplicate of No. 1 Dubbs, namely No. 2 Dubbs, was down early and full of quench water, awaiting cleanout the next day. The two units were located side by side (see Fig. 1) and No. 2 also had two coke drums and a dephlegmator.

These Dubbs units have been a source of pride for their long service. In over 30 years of cable pulling—coke-out operation on a three-day cycle—the two units have probably been brought onstream a total of over 6,000 times.

But what are the odds for a detonation on startup? One in 6,000? One in 6,001? One in 1,000,000?

We had long since ceased to keep a record of the startup numbers, but the description of the startup procedure which follows will be the last for a Dubbs coker in the Ponca City refinery of Cities Service Oil Co.

Operating Procedure. The cleanout crew turned No. 1 Dubbs coker over to operations shortly after 9:00 p.m. January 21, 1959. The evening operator then checked valve line-ups, ram out level and pressure-gage lines prior to filling the unit with oil.

Filling the units completely with oil at each startup has been a long-established practice designed to accomplish three things:

1. Purge air from unit

2. Permit pressure test for leaking flanges and furnace plugs

3. Permit check of relief valve operation and set pressure

Filling Process. The Dubbs coker flow diagram in Fig. 3 describes the filling process as follows:

A large-volume, low-head centrifugal pump transfers oil from the startup tank to the bottom of the reaction chambers, while a smaller reciprocating pump charges material through the furnace to the top of the chambers. The material used for filling the unit is a blend of decanted oil and tar, coming from storage at a normal temperature of 200° F. On this particular night, because of the cold weather, the oil temperature was down to 150° F, making it quite viscous and difficult to transfer.

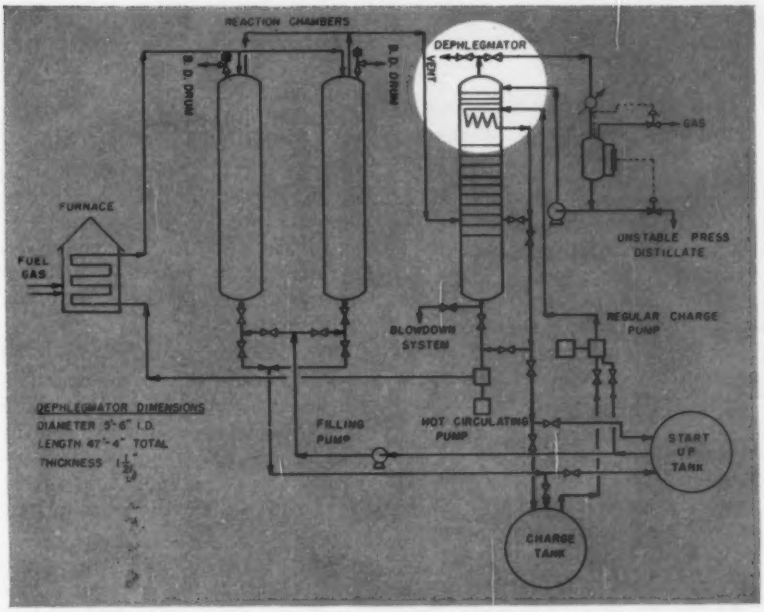


FIGURE 3—The vent valve remained closed as the pressure continued to build.

During the filling operation, the vent line from the top of the dephlegmator is open to allow the air to escape from the unit as oil displaces it. On this particular night, the evening shift operator *failed to open the vent valve* when lining up the unit.

In continuing with the normal filling procedure, after the two reaction chambers are full, oil overflows through the overhead vapor line into the dephlegmator. When the dephlegmator is full, as observed by an overflow of oil from the vent, the vent valve is closed to build pressure to 225 lb. for pressure test and check of relief valves located on top of the reaction chambers. The relief valves on the chambers also provide relief protection for the dephlegmator, inasmuch as there are no valves in the vapor line between the vessels.

After the pressure test is complete, the hot oil circulating pump is started and furnace fires lighted in preparation for bringing the unit onstream.

Valve Stayed Closed. The filling pump had been started only a short time prior to arrival of the hoot shift operator at 11:00 p.m. as is customary, the hoot shift operator proceeded to recheck the unit line-up. This was the start of a series of unfortunate circumstances. The hoot shift operator, probably in haste to get out of the cold, failed to catch the previous operator's mistake. *The vent valve remained closed.*

Normally, filling takes three to four hours when charge stock is hot and free of coke particles. The operators observed that the unit was filling slowly. They attributed this to cold charging stock and possible plugging of the filling-pump suction screen with coke fines.

Later, around 1:30 a.m., the filling pump began to run hot and was shut down. This hot filling pump was a clue which, if grasped, could have brought about a true diagnosis of the trouble. The filling pump had reached its maximum discharge pressure of approximately 90 psig due to compression of air in the system. The lack of fluid movement through the pump caused it to become hot.

Two things are probably responsi-

ble for the operators' failure to catch the true significance of the hot pump:

1. Filling time had been long on some recent runs as a result of plugging of the suction strainer on the filling pump.

2. The pressures recorded on the suction and discharge of the hot circulating pump, through which the regular charge pump was simultaneously filling through the furnace to the top of the chambers, did not appear to be significantly higher than normal.

A Low Fire. After the main filling pump had been shut down, the operators gave conscientious thought to ways of speeding up the filling process. They concluded that lighting a low fire in the furnace would be desirable. In this manner, more oil could be moved through the heater because of lower viscosity and pressure drop. Further, they reasoned that by warming up the charge and furnace, the later operation of "pulling levels" could be facilitated.

Lighting a fire in the furnace at this stage of startup was not normal. However, this had been done on some occasions, with permission of the unit foreman, when the unit was down for an extended period which allowed the furnace to cool abnormally. This, however, was the first time operators had taken the liberty of lighting the fire without approval of the foreman. In view of the extended unit cleanout time and the low atmospheric temperature, had the request been made, no doubt approval would have been given along with some words of precaution on high oil temperatures.

At 4:30 a.m. the pressure upstream of the furnace was 90 psig and increasing. Charge rate through the heater was approximately 800 bpd, with a low fire still being maintained. No oil had yet overflowed into the dephlegmator as observed from the float level indicator.

At 5:30 a.m., an oil level was indicated on the dephlegmator-bottoms level instrument. Pressure had increased to almost 130 psig, but had not yet aroused concern. At this time, furnace transfer temperature was observed to be 450° F. Instead of reducing the furnace firing rate, the operators managed to increase the charge to 1,700 bpd, which lowered the temperature to 350° F.

Pressure Keeps Building. When the feed was increased at 5:30 a.m., pressure at the furnace inlet began to increase at approximately 6 lbs. per minute. The operators were not alarmed at the first increase in pressure because they attributed it to additional pressure drop through the furnace tubes.

The pressure continued to rise. As it approached 200 psig, the operators did become concerned and activated the coke-chamber pressure instrument for a pressure check. This instrument was normally left out of service until after the pressure test to prevent overranging.

When they got their check, the worst was confirmed. Pressure at the top of the coke chamber had reached 200 psig and was still climbing. Pressure at the furnace inlet had now reached 250 psig.

Too Late. Now everything was clear—either the vent line was plugged or the vent valve was closed. The stillman immediately confirmed that the vent vale was closed. No. 1 Dubbs operator was dispatched to open the valve at once. No. 2 Dubbs operator went along to assist.

They found the valve could not be opened by hand. No. 2 Dubbs operator walked around the dephlegmator in search of a wrench. Meanwhile, chamber-top pressure had reached 250 psig, and furnace inlet pressure was 300 psig. It was too late.

At exactly 6:00 a.m., January 22, 1959, No. 1 Dubbs dephlegmator was ripped by a violent explosion. The vent valve was never opened.

Cause of the Explosion. There is now little doubt that the explosion

TABLE 1—Properties of Cracked Gas Oil
Date of Sample: January 23, 1959

ANALYSIS OF TEST	418 TANK (RAM OIL)			
	Top	Middle		Bottom
Distillation, °F:				
Initial boiling point	160	170	286*	200
5 percent recovered	360	364	418*	356
10 percent recovered	406	410	444*	406
20 percent recovered	449	453	482*	454
30 percent recovered	487	493	518*	495
40 percent recovered	520	528	564*	533
50 percent recovered	554	564	614*	570
60 percent recovered	595	603	648*	606
70 percent recovered	632	640	678*	640
80 percent recovered	668	674	722*	675
90 percent recovered	.....	.....	808*	.....
94 percent recovered	.....	.....	870*	.....
Percent recovered at 700° F	88.0	87.0	.....	87.0
Gravity, degree API	28.8	28.6	.....	28.5
Flash point (Tag closed), degree F	90	90	.....	90
Fire point, degree F	90	90	.....	90
Basic sediment, percent	Trace	Trace	.....	Trace
Water by distillation, percent	0	0	.....	0
Pour point, degree F	35	35	.....	35
Ramsbottom carbon residue, percent	0.43	.....	.....	0.46
Sulfur, percent	0.77	0.78	.....	0.67
Viscosity (Saybolt Universal) at 210° F, sec	17.5	17.5	.....	17.5

* Vacuum distillation.

TABLE 2—Minimum Spontaneous Ignition Temperature Data as Determined by United States Bureau of Mines Laboratory
(Spontaneous Ignition Temperature in Air Atmosphere)

MATERIAL	Initial Pressure (Pounds Per Square Inch Gage)	Spontaneous Ignition Temperature		Time Lag Before Ignition (Seconds)
		Degrees Fahrenheit	Degrees Centigrade	
Dephlegmator residue	0	712	378	2
	100	522	272	25
	250	550	288	10
Ram oil (top, 418 tank)	0	482	250	85
	100	475	246	63
	250	493	256	45
Ram oil (middle, 418 tank)	0	478	248	91
Ram oil (bottom, 418 tank)	0	469	243	64
Dubbs charge (top, 431 tank)	0	838	448	5
Dubbs charge (middle, 431 tank)	0	774	412	3
	100	583	316	2
	250	658	348	3
Dubbs charge (bottom, 431 tank)	0	802	428	5
Sample from No. 1 Dubbs unit, No. 1 level (near draw)	0	770	410	3
Sample from No. 1 Dubbs unit, No. 1 level (far draw)	0	810	432	5

was caused by spontaneous ignition of ram oil vapors in the dephlegmator.

Ram oil is a light gas oil product produced in thermal cracking operation. It is used in small quantities before each startup to flush out valves, drains, level lines, and pressure connections. Properties of ram oil are shown in Table 1.

Spontaneous ignition temperatures for ram oil were determined by the Bureau of Mines at various pressures. The results are shown in Table 2, along with those for all other oil samples associated with the startup. You will note that ram oil has by far the lowest spontaneous ignition temperatures. The range is from 469° to 493° F. From Table 1, you will also observe that ram oil is quite volatile. Approximately 20 percent is vaporized at a temperature of 450° F.

Pressure and Volume. An analysis of the pressure and volume ratios just prior to the explosion reveals that the compression, under the circumstances, more nearly followed an adiabatic path. With a final dephlegmator pressure of approximately 250 psig, the pressure ratio (Pf/Pi) was 18. The corresponding final volume ratios (Vi/Vf) would be 18 and 8, respectively, for isothermal and adiabatic compressions.

Based on the best information available on the amount of oil in the dephlegmator at the time of the explosion (estimated one-quarter to on-half full), the Vi/Vf ratio was approximately 10 when the explosion occurred. Apparently, for this to be accomplished, the heat lost from the compressed air to vessel walls must have been almost completely regained from the hot charge stock.

A conservative estimate of the final gas temperature near the surface of the hot liquid was 500° F. Thus theory seems to verify that sufficient temperature did exist to both vaporize and spontaneously ignite ram oil.

A very comprehensive analysis of this subject is made by Dr. M. G. Zabetakis in the Bureau of Mines, Division of Explosives Technology, Report No. 3730. Also, in this same report, Dr. Zabetakis duplicates very closely in theory the rates of pressure rise which actually existed prior to the explosion.

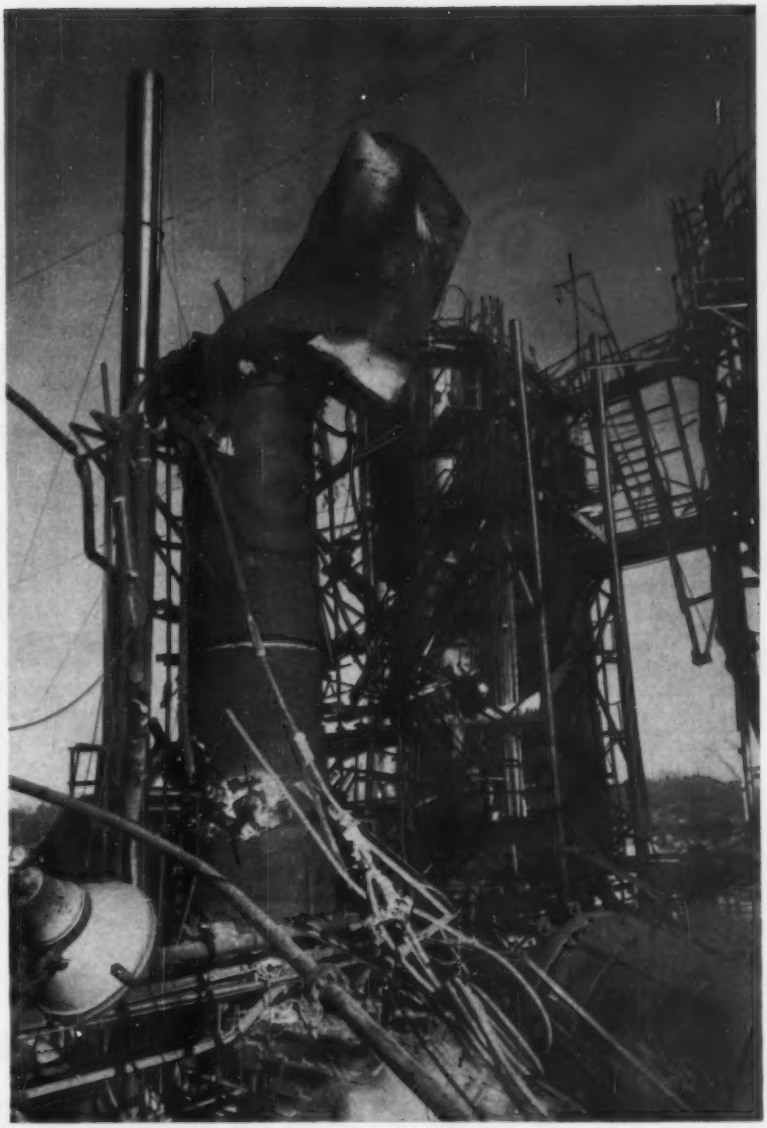


FIGURE 4—Clean fractures of the dephlegmator fragments indicate without doubt that failure occurred through detonation.

Failure Through Detonation. The clean fractures of the dephlegmator fragments, free from any thinning at the points of rupture, indicate without doubt that failure occurred through detonation at pressures much higher than would be experienced with slow combustion or deflagration.

The cause of an explosion such as this can never be stated with absolute certainty, but the conclusion that it occurred through spontaneous ignition of ram oil vapors seems justified. Thus we can reasonably say that, if the human error which resulted in the vent valve remaining closed had been corrected, an explosion would not have occurred because the spontaneous ignition temperature would not have been reached. Further, even if the spontaneous ignition temperature had been reached and the vent valve had been opened any explosion would have been greatly reduced because of the smaller quantity of air available for combustion.

Other possible triggering mechanisms considered as possiblities were:

1. Spontaneous ignition of iron

sulfide deposits on the top dephlegmator trays.

2. Static spark resulting from movement of liquid and vapor caused by opening of the relief valves.

The latter did appear to have some merit, inasmuch as it seems like more than just coincidence that the explosion occurred almost exactly at or just slightly above the relief pressure.

Personnel. When the explosion occurred, three men were in the control room. Two men were at the base of No. 1 dephlegmator, as previously described, and one man was in the tool house located directly north of the unit.

The burning liquid contents of the dephlegmator spilled out of the ruptured vessel toward the northeast. This was the area in which No. 2 Dubbs operator had walked in search of a valve wrench; he was killed instantly. No. 1 Dubbs operator, standing approximately 15 feet on the opposite side of the tower was miraculously unharmed.

The shock wave and initial wall of flame caused the windows in the north and south ends of the control room to cave-in. The three men in the control room left the building through the west door. Only one minor injury, a head laceration, was inflicted. The man in the tool room could not get out the west door because of the flame. He departed through a north window unharmed.

We were deeply grateful that there was no greater loss of life and injury to personnel. In another 2 hours, 16 coke-out men would have been in the area. This would have been a tragedy. It is also fortunate that No. 2 Dubbs was down for cleanout; otherwise, the resulting fire would have been tremendous. As it was, the fire was not great after the explosion. It was well contained within 15 min. and completely extinguished in 30 min.

The operators promptly isolated the hydrocarbons feeding the fire. This included a gas line to the heater, which was broken, and charge, which was still being pumped to the reaction chambers and overflowing into the dephlegmator. Steam lines, air lines, and many others were broken. Block valves remote from the unit area proved to be very valuable for the prompt containment of the fire.

Fragments Well Scattered. Fragments of steel from both the dephlegmator and its surrounding platforms and structure were scattered over a large section of residential and refinery area. The largest dephlegmator fragment weighed 7,440 lbs. and was carried 100 ft. It came to rest uncomfortably close to a stabilizer heater which was in operation.

A 2,500-lb. fragment, including the top head of the dephlegmator, was blown 335 ft. into a residential area. This was the largest fragment carried out of the refinery.

Further illustration of the damage caused by the explosion is given in Fig. 4, which shows the portion of the dephlegmator left standing after the explosion.

Damages. Fortunately, there were no major injuries or fatalities in the residential area. There were some minor personal injury claims and over 600 claims for personal property damage amounting to over $200,000.

Shrapnel was found up to 1,000 ft. from the base of the dephlegmator. Window damage and plaster damage from the shock wave were reported up to 5,000 ft. and 2,500 ft. respectively.

The Bureau of Mines estimated the explosion to be equivalent to that of 800 lbs. of solid explosive. An almost equivalent energy release would be obtained from approximately 6 gallons of oil and the amount of air compressed in the dephlegmator.

Some Reflections. The hazards of air in refinery processing cannot be overemphasized. In this case of human error, one cannot help but wonder if it could have been avoided through better training techniques. Through the years, had the operators, in their own minds, been filling the unit to pressure test only? How would it be possible for an operator to forget to open a vent valve if, through the years, it had been instilled in him that the unit was being filled to *purge the air and prevent explosions?*

Yet, when we later questioned various operators about how important they thought it was to have the vent valve open when filling, they all, without exception, knew that it was absolutely essential, and why.

This experience also reveals that we must be aware of the seemingly harmless changes in operating procedure which may grow out of some particular expediency. There is a tendency to say, "Well, it must be a good startup procedure; it has worked for over 30 years." Has it worked because it is right, or have the odds failed to catch up?

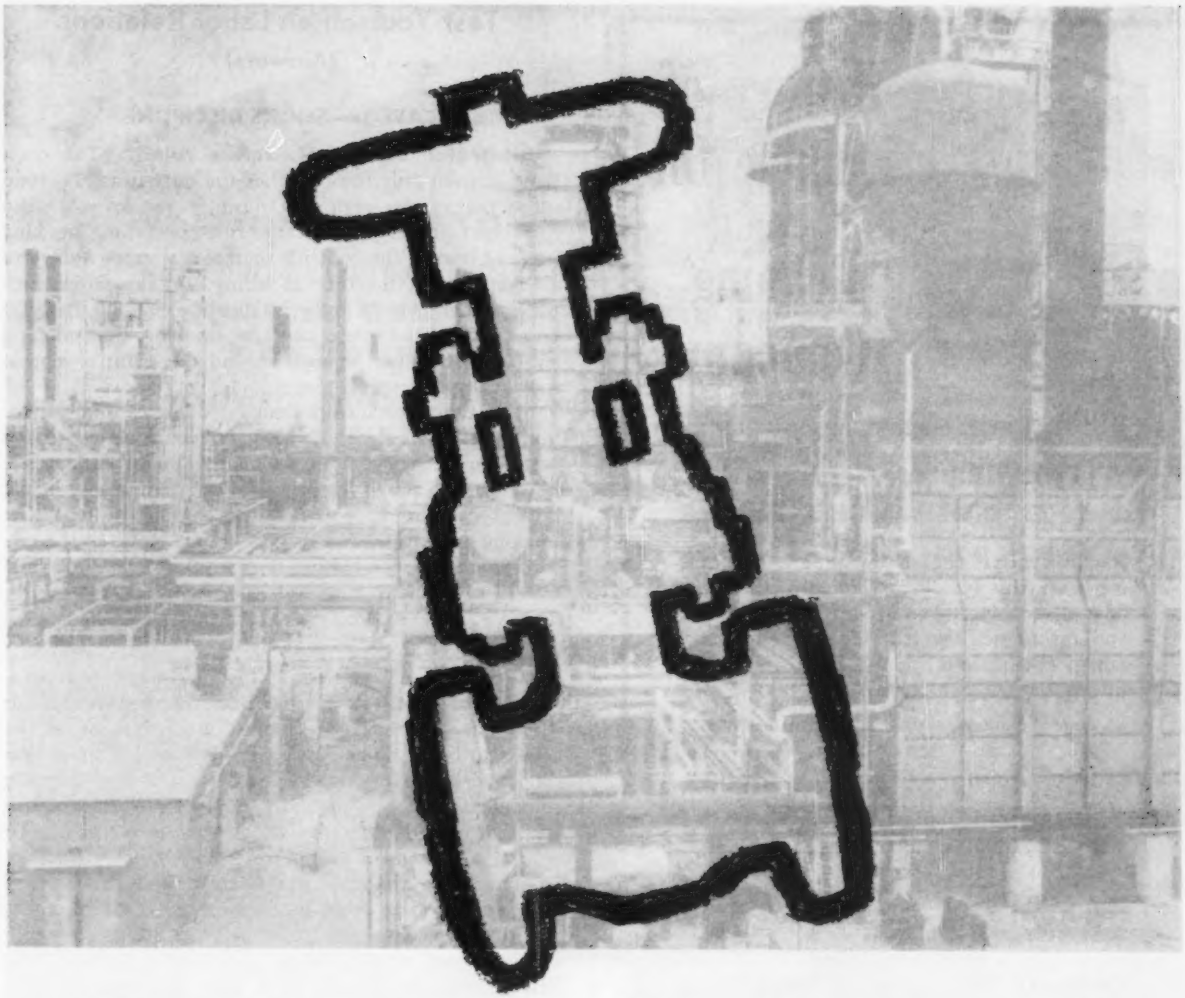
We must be frank and admit that, as a result of this explosion, we have reviewed our operating procedures on other units and have corrected two unsafe practices which have been in effect for years on the two oldest units in the refinery. In one case, a stabilizing unit was being purged by displacing air with gas rather than first purging with steam and then breaking with gas. The other case involved a startup procedure on a thermal cracker where air was being displaced with hot vapors generated in the process of circulation.

Yes, a process can be immune from detonation, but first it must be inoculated with a startup procedure which eliminates the contact of oil with air.

(Presented at the annual API meeting, Refining Division, Chicago, November, 1959.) ##

About the Author

Omer A. Pipkin joined Cities Service Oil Co. in 1950 after receiving a B.S. degree in chemical engineering from the University of Oklahoma. He has held various positions with Cities Service as process engineer, operating foreman, and project engineer before attaining his present position as cracking superintendent of the Ponca City refinery in 1957.



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Frankly, we cannot give credit to any one individual, or even to a group of individuals, for the design of STANCO Valves. They are the end result of a manufacturer — with complete facilities for pattern making, casting, heat treating, machining, assembling and laboratory testing — working closely with leading pipeline and refinery engineers to develop superior valves to solve their particular problems.

STANCO Ductile Iron* Valves are field-conceived, field-tested, and field-proven. They possess the qualities refinery engineers demand to meet the problems unique to their industry. They have corrosion resistance equal to that of cast iron, elevated temperature strength comparable to that of cast steels, and thermal shock resistance equal to that of cast carbon steels. And they are *pressure tight*. Ductile iron has a metallographic structure which resists leakage or seepage by liquids and gases.

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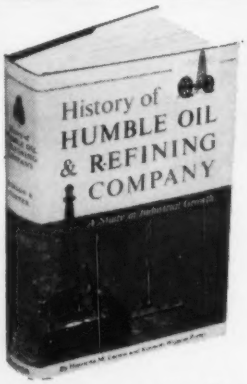

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Test Yourself on Labor Relations

(Answers)

CASE 1—SMOKE DISCIPLINE

Arbitrator Samuel H. Jaffee ruled: "The company has not only the right but the duty to take certain safety precautions—not only to protect employes but also to protect property. While the rule concerning smoking was not posted, the contents thereof was made known to all employes at the time of hiring and thereafter. Employes generally, and the grievants in particular, had full knowledge of the rule concerning smoking, that smoking was not permitted 'in and around the plant except in specifically designated places.'

"The term 'specifically designated places' did not require posting of signs. These places could be designated orally and they were so designated to all employes—not once but many times. There was no necessity in the present case for a sign to be placed on the roof that smoking was prohibited in that area. Under all the circumstances of this case it is clear that there was just cause for these two employes to be disciplined."

CASE 2—JURY DUTY

Arbitrator Milton T. Edelman (chairman) ruled: "Jury duty represents a rather common type of benefit agreed to by many employers and is found in numerous collective bargaining agreements. Its aim is to provide competent jurors through the removal of the monetary loss that would otherwise accompany jury service. To require a second-shift employe to be available for jury service during the day and later to work his regular shift, ending after midnight, is to remove the incentive for jury service, which is the primary aim.

"To argue, as the company did, that perhaps Mr. Patchin did not actually serve on a jury but was only available for service, and therefore could have easily reported by 4 p.m. cannot be carried through logically. What if a first-shift employe is released from jury service by 10:30 a.m., should he report for work before noon and complete his shift? The company admitted it had no policy on such a question. If the company's argument were accepted, how late would a first-shift employe have to serve before reporting on his regular shift?

"The fairest application would seem to be that employes called for jury duty should receive the difference between their regular pay and the amount given them for jury service whether they actually serve on a jury or are only required to be available to the court for jury service, but do not actually serve."

CASE 3—COMPANY PERSONNEL RECORDS

Arbitrator Louis S. Belkin ruled: "I shall not require an employer to disclose any of his records or methods of housekeeping to the union. No union has a right to such information any more than a company has the right to an examination of the union records. Therefore, I shall hold that the company may develop any forms it wishes and that the forms are not subject to negotiation or revision or examination by the union."

For more data on advertised products, use Readers' Service Cards, last page.

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looks for specialized durability in
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PRESSURE-SEAL VALVES
. . . and here's how he gets it

When the Walworth Customer selects valves for special needs in fluid flow control, he insists on knowing that each type will do its job for a long time, with minimum maintenance. In Walworth Bronze Valves, for example, he finds generous wall thickness, and extra-large stems with extra-deep threads.

In Iron Body Gate Valves, the Walworth Customer checks fully open valves for the free flow of fluids. He finds streamlined ports in the Walworth Cast Steel Gate Valves to fight turbulence and pressure drop.

Tight and fast closures are on his mind when he decides on an LPV, and he finds 100% tight closure in the Walworth Lubricated Plug Valve. It is lubricant-sealed against leakage, opens or closes with a quarter turn, and can be serviced under pressure.

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In his persistent quest for hard facts about materials, workmanship and high quality in the special valves he buys, the Walworth Customer gets his decisive answers in products bearing the Walworth name. If you, too, insist on verifying solid quality for yourself whenever you buy valves, we want you, too, for a Walworth Customer. For the newest literature on any type of Walworth Valves get in touch with your Walworth Distributor.

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For more data on advertised products, use Readers' Service Cards, last page.

LPG Sales Jump 16.5 Percent in 1959

Upward trend is expected to continue. Chemical manufacturing gains bigger bite of total

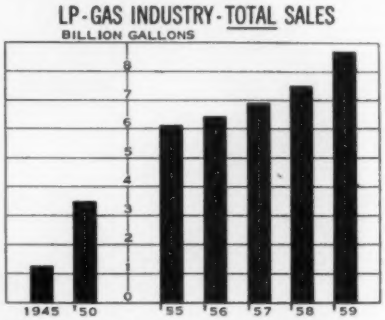
LPG sales in 1959 continued to boom and appear to have increased 1,231,000,000 gallons (16.5 percent over 1958) raising total sales to 8,693,000,000 gallons. This compares with an increase of 7.5 percent in 1958. The trend should continue because of large potential markets for chemical, domestic and motor fuel uses.

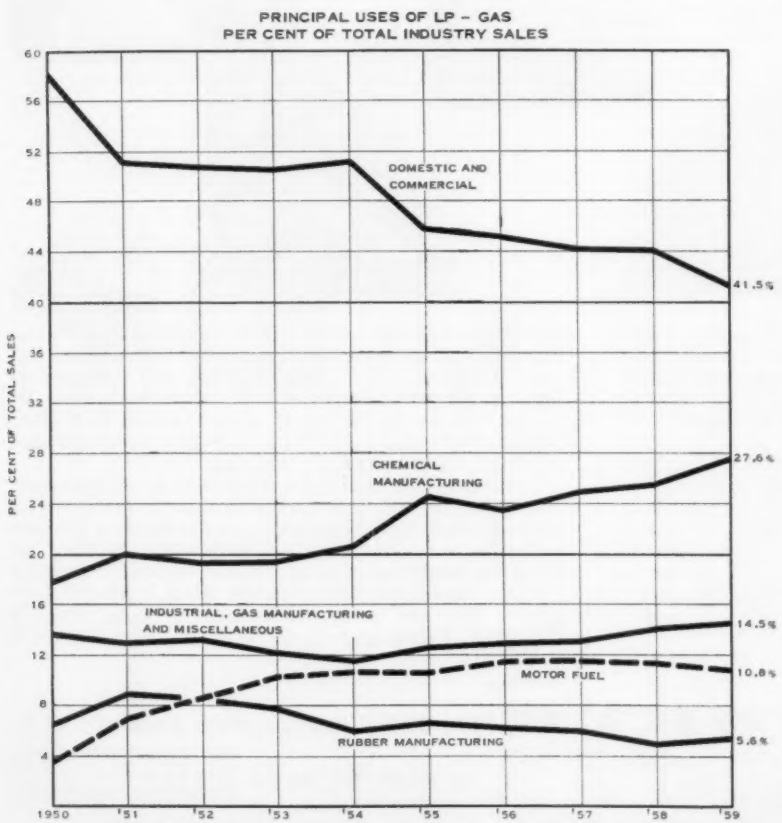
Domestic and Commercial—Sales were up 310,000,000 gallons (9.4 percent over 1958) to 3,604,000,000 gallons. The volume of domestic and commercial sales continued to increase. However, their percent of total LPG industry sales decreased from 44.1 percent to 41.5 percent in 1959.

Motor Fuel—Sales were up 85,000,000 gallons (10 percent over 1958) to 937,000,000 gallons. The 1959 LPG motor fuel sales represented 10.8 percent of the total LPG industry sales.

Industrial and Miscellaneous—Sales were up 214,000,000 gallons (26.5 percent over 1958) to 1,020,000,000 gallons. LPG used in refineries for fuel contributed heavily to this tremendous increase. These sales have almost doubled in the past five years.

Gas Manufacturing—Sales were up 6,000,000 gallons (2.6 percent over 1958) to 245,000,000 gallons. These sales have remained fairly constant for the past five years.





Chemical Manufacturing—The sale of LPG as a raw material for the manufacture of chemicals was up 497,000,000 gallons (26.2 percent over 1958) to 2,396,000,000 gallons. This tremendous increase is due principally to the increasing market for petrochemicals. Chemical use of LPG continues to take a larger percentage of the total industry market. This percentage increased from 20.5 percent in 1954 to 27.6 percent in 1959.

Rubber Components—The volume of LPG consumed in the manufacture of synthetic rubber was up 119,000,000 gallons (32 percent over 1958) to 491,000,000 gallons. This large increase was due principally to the increase in automobile production in 1959.

LPG Appliances—Sales of LPG consuming appliances showed a strong upturn during 1959—in spite of the prolonged steel strike. The increases were in line with new family formations, new housing starts and the general level of consumer buying.

Supply—Production of LPG (including the mixed streams going to petrochemi-

Again in '60

(the 38th year!)

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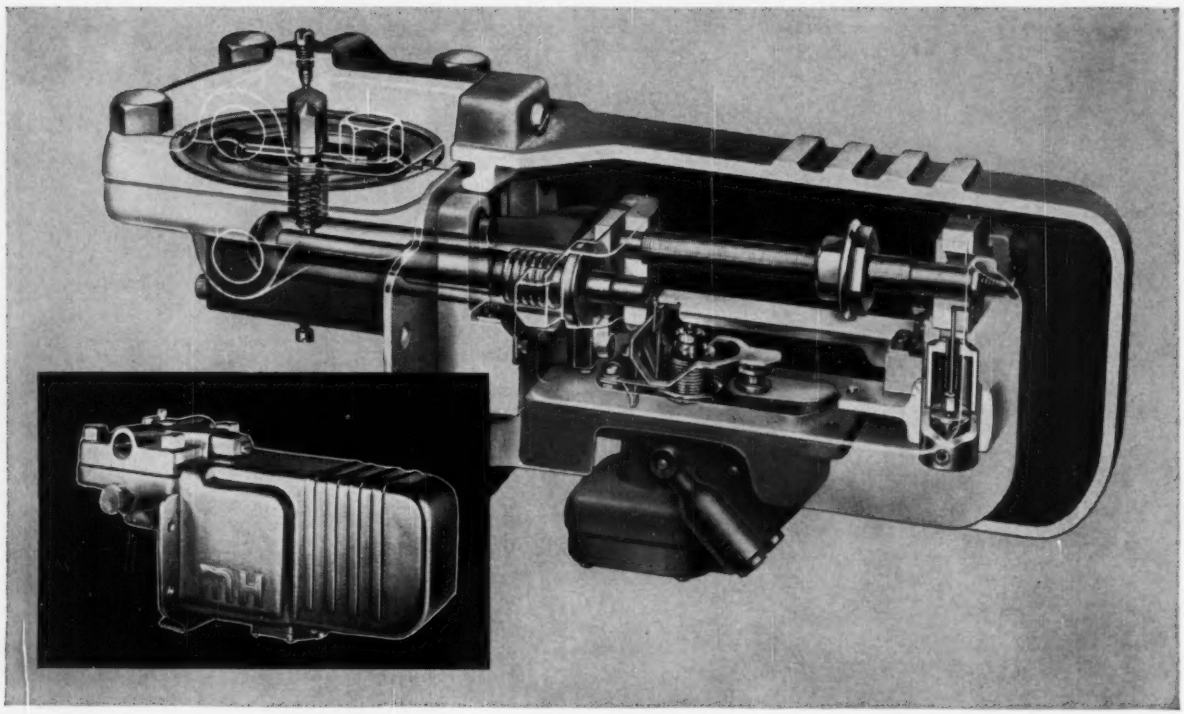

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Happenings . . .

cal use and refinery fuel) was nearly 18 percent over 1958—but part of this apparently large increase is due to more complete coverage of many mixed streams.

Eleven new plants came on stream in 1959 and several others were expanded during the year. It is estimated that 16 new plants will come on stream in 1960.

Significant expansions were made in Canadian production capacity—thus keeping production in advance of the increased demand developing there.

Transportation—Expansion of LPG transportation facilities continued during the year but at a more moderate pace than in recent years.

The Little Big Inch pipe line was converted to refined products (including LPG) last year but expansion and improvement of facilities on the line for handling LPG continued during 1959. This resulted in the line having an increased effect on the transportation of LPG to the Eastern United States. In addition, at least two short LPG lines were placed in operation in the Southwest during the year.

One new ocean going tanker was placed in LPG service during the year. Of interest, although presently not affecting the industry in the United States, was the start of construction on a water terminal for the storage and shipment of refrigerated LPG in Saudi Arabia.

Continued emphasis was placed on larger capacity highway transport units, both in "over-the-road" units as well as "bobtail" delivery units. The trend toward 10,000 gallon (and over) capacity transports continues strong and 2,500 gallon and larger, bobtail units are becoming more common. Coupled with this the industry is becoming more conscious of the importance of efficiency in loading and unloading these larger units. This has resulted in more interest in higher capacity pumps, piping, etc., and also, use of positive displacement meters to provide fast, accurate measurement of product loaded into transports.

A continued interest in larger LPG tank cars was evidenced during the year, but was curtailed somewhat by the steel strike. The trend is to cars of around 20,000 gallon water capacity, but one company reportedly is studying the possibilities of 30,000 gallon water capacity tank cars.

Safety Developments—The most significant development in industry safety standards during the year was the combining of NFPA Pamphlet 52 (LPG Piping in Buildings) and 54 (Utility Gas Piping) into a new Pamphlet 54 (Gas Piping in Buildings). This pamphlet is also an ASA Standard, ASA 721.30. This major step forward was the result of some four years joint efforts by representatives of the LPG industry and the utility gas industry. NFPA Pamphlet 58 was also revised again to recognize the advancements in equipment and safe operating techniques.

Outlook—Well managed LPG companies are expanding operations by installing

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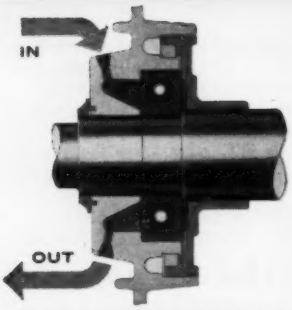
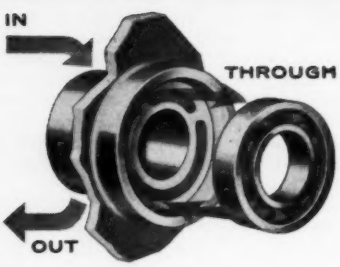
For most applications, open greasable bearings will serve dependably and economically. But for use where lubrication maintenance is difficult, Elliott offers a pre-lubricated cartridge type which requires no service lubrication.





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W 9-4

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CROCKER-WHEELER PLANT JEANNETTE, PA.

Happenings . . .

bulk plants at additional locations in contiguous territories and by increasing coverage of present territories. Better managed operators continue to search for and develop load building and ratio leveling uses for products and services. Management schools were popular during the year. More LPG business men are realizing that continued analysis of the financial phase of an operation is the best avenue to insure continued development.

Bureau of Mines Reports On Natural Gas Liquids

The daily average production of natural gas liquids in October was 37.2 million gallons, an increase of two percent above September 1959, according to the Bureau of Mines. The daily average production of liquefied gases at refineries was 7.5 million gallons, the same as in November. Daily average demand for liquefied gases for fuel and chemical uses was 25 million gallons, 12 percent above September 1959. Daily average demand for natural gasoline at refineries remained at the average of the last few months of 11 million gallons. Stocks of liquefied gases totaled 1.188 billion gallons including 997 million gallons in underground storage. Stocks of liquefied gases decreased 34 million gallons during the month.

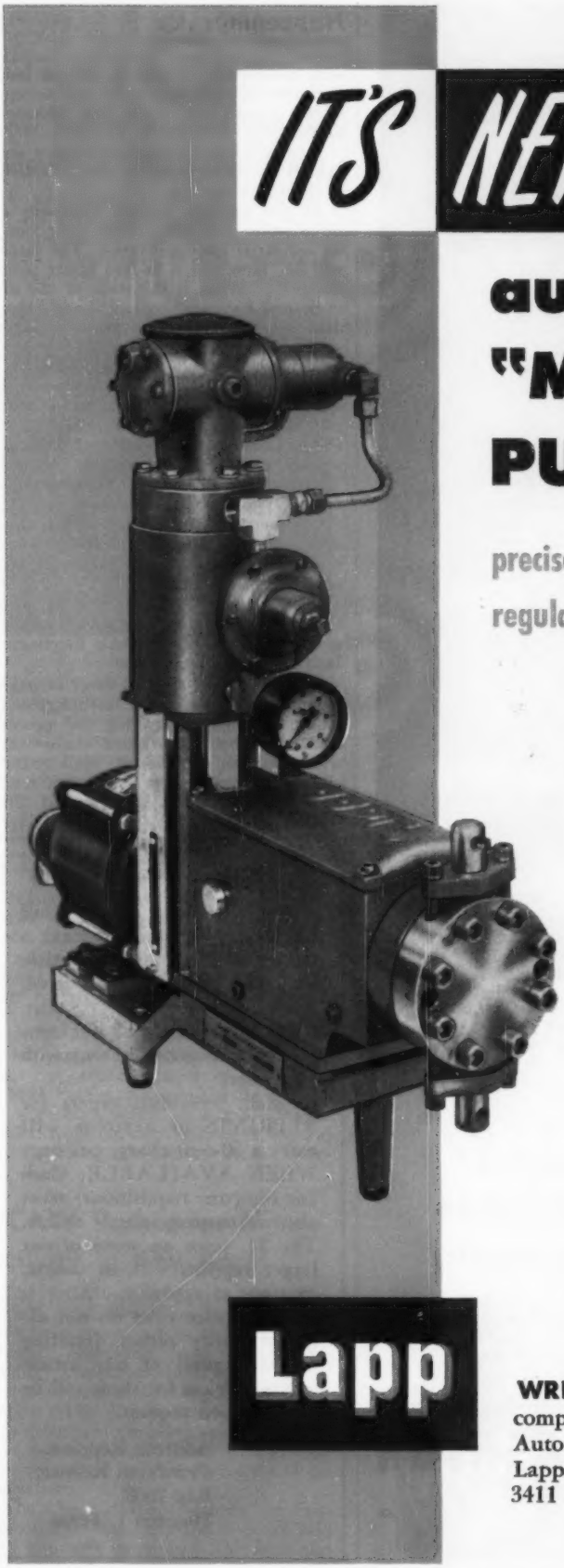
High-Density Polyethylene Hits 90 Million Pounds

Introduced commercially less than three years ago, high-density polyethylene achieved a 90-million-pound sales volume during 1959 to set a pace as America's fastest growing major plastic in history, according to Richard W. KixMiller, president of Celanese Plastics Co. The industry's 1959 production of the plastic represented a tenfold increase over that of 1957 and was nearly double the 1958 volume. KixMiller predicated that future consumption of high density polyethylene in such volume markets as containers, toys, housewares and industrial components could accelerate on a scale closely approaching the growth rate recorded during the past three years.

During 1959, conventional polyethylene (introduced in 1942) became the first plastic to achieve an annual consumption of one billion pounds. "Considering the meteoric growth rate recorded by high density polyethylene during the less than three years' commercial existence, an eventual billion-pound-per-year consumption of this material likewise is entirely conceivable," KixMiller said.

ISA Instrument-Automation Scheduled for February 1-4

The Rice Hotel, Houston, will be the scene February 1-4 of the first of three instrument-automation conferences and exhibits scheduled for 1960 by ISA. The conference, featuring 22 technical sessions



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auto-pneumatic "MICROFLO" PULSAFEEDER

precise pumping at micro-flow rates
regulated by pneumatic control instruments

Here's a controlled-volume metering pump that will vary its microflow rate of output automatically to a changing process condition. Auto-Pneumatic Microflo Pulsafeeder is a piston-diaphragm pump with no stuffing box or other seal—it handles fluids without contamination or leakage.

Output of a standard Microflo is governed by controlling the travel of its piston. This is done manually through a micrometer. In the Auto-Pneumatic model, an air cylinder performs this operation. As a change in a process condition occurs, a pneumatic control instrument senses the change, records it and sends an air pressure signal descriptive of the changed condition. Auto-Pneumatic Microflo Pulsafeeder reads this air signal and changes its pumping rate accordingly.

Four models are available with flow rangeability of 10 to 1 and a flow range from 585 ML per hour maximum up to 1.2 gph maximum. Reagent head assembly is made from Carpenter No. 20 Stainless, Diaphragm is Kel-F and valves are Hastelloy C. Other materials are available on special order.

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WRITE FOR BULLETIN 500-A containing complete description and specifications on the new Auto-Pneumatic Microflo Pulsafeeder.
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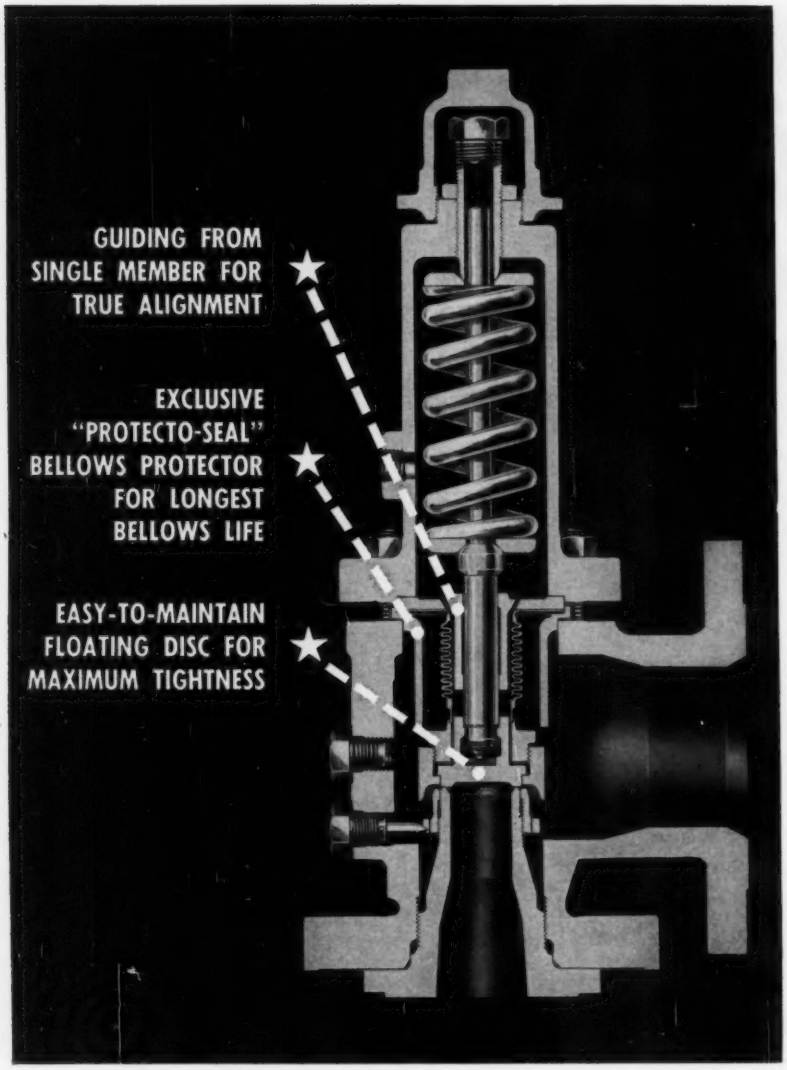
For more data on advertised products, use Readers' Service Cards, last page.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Happenings . . .

with more than 72 papers, will be held in the hotel, while the exhibit will occupy 25,000 square feet in the Sam Houston Coliseum.

This full-scale national conference and exhibit has as its theme "Process Control in the Electronic Era."

At the keynote session, February 1, three authorities will present their views on industrial instrumentation. The facets will be "How will it fit into future plant design?"; "What is the state of the art in process computer control?" and "How does automation actually relate to labor and productivity?"

At other technical meetings, ACS, as a cooperating society in the conference, is sponsoring two of four sessions on analysis instrumentation. Two sessions of ISA's Chemical & Petroleum Division feature papers on computer control. There also will be a single session on data handling and computation.

There will be a maintenance management workshop covering personnel selection and training, labor relations, and equipment reliability.

One of the "firsts" at the Houston Conference is to be an electronics service seminar, organized by ISA's Electronics Instrumentation Division.

Other technical sessions cover management and economics; pipe line instrumentation; systems engineering for process computer control; a sales engineering workshop; an instrument maintenance clinic, and one is concerned with management and control. ISA's second 1960

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conference is to be held in San Francisco May 9-12. The third will be the international conference and exhibit, New York, September 26-30.

New Safety Record Set By Tidewater Delaware Plant

A new safety record for Tidewater Oil Co.'s Delaware refinery was set in December when employes completed one million man-hours of work without a lost-time injury. Tidewater President

George F. Getty II (right) marks the occasion by presenting Eastern Division manufacturing manager George C. Caine with a Tidewater award certificate. The new safety record of the modern 150,000-bpd refinery is currently well over the million-hour mark, and still rising.

Refiners Gain $8 Million In Last Quarter of 1959

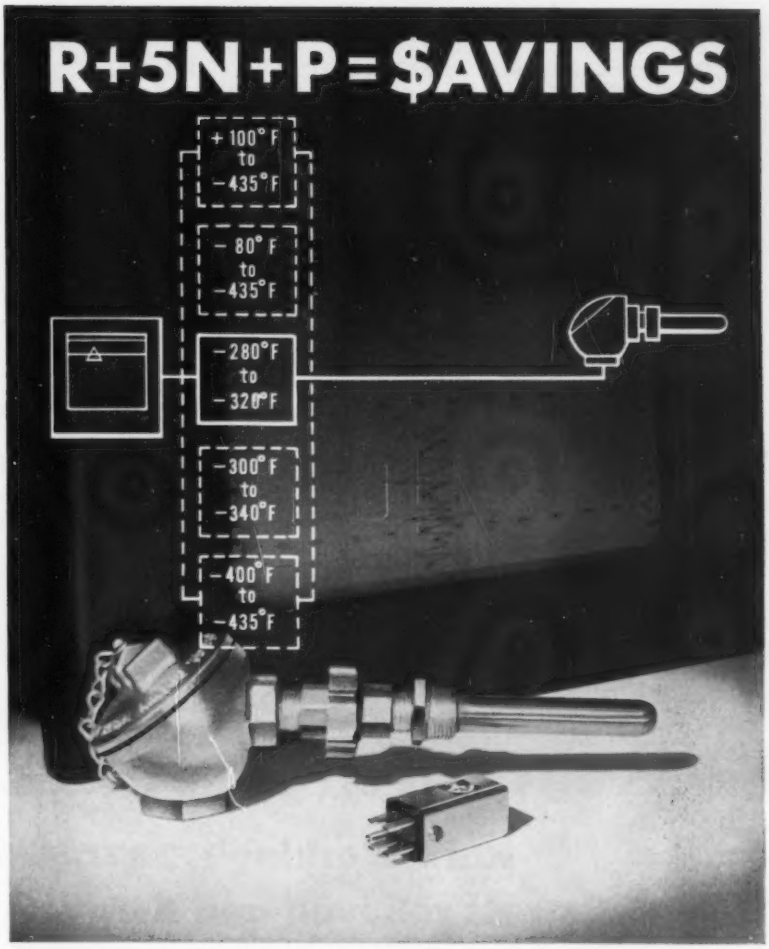
Refiners, including integrated companies, reported $656 million in net profits for the third quarter of 1959, or a gain of $8 million compared with the third quarter of 1958, according to a joint financial report of the Federal Trade Commission and Securities and Exchange Commission.

Net profits also showed an increase from the second quarter of 1959 total of $621 million. Sales in the third quarter were $6.9 billion, or a gain of $409 million from the third quarter, 1958, and a $323 million gain over the second quarter, 1959.

OCAW Pushes for More Activity in Key Areas

The OCAW has advised members through its *Union News* that organizers have been regrouped to accelerate "significant" organizing projects—those involving "comparatively large groups of people in strategically important" installations. "The Union has had so many organizing projects going at once that we have been spread too thin," said E. Carl Mattern, newly appointed director of organization.

The Union did not identify the "significant" projects, but *Union News* said they number "more than 20." It is also



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REC's many Resistance Temperature Probes, when used with the Model 173 Plug in Trimming Network covers the entire temperature range from −435°F to +100°F and higher, with absolute accuracy and interchangeability of ± 0.1°F.

Standard Networks are available to adapt any probe to the temperature spans indicated above.

- **PROBE AND NETWORK FITS MASTER CALIBRATION CURVE TO ± 0.1°F . . . ELIMINATES CALIBRATION . . . .$AVINGS**
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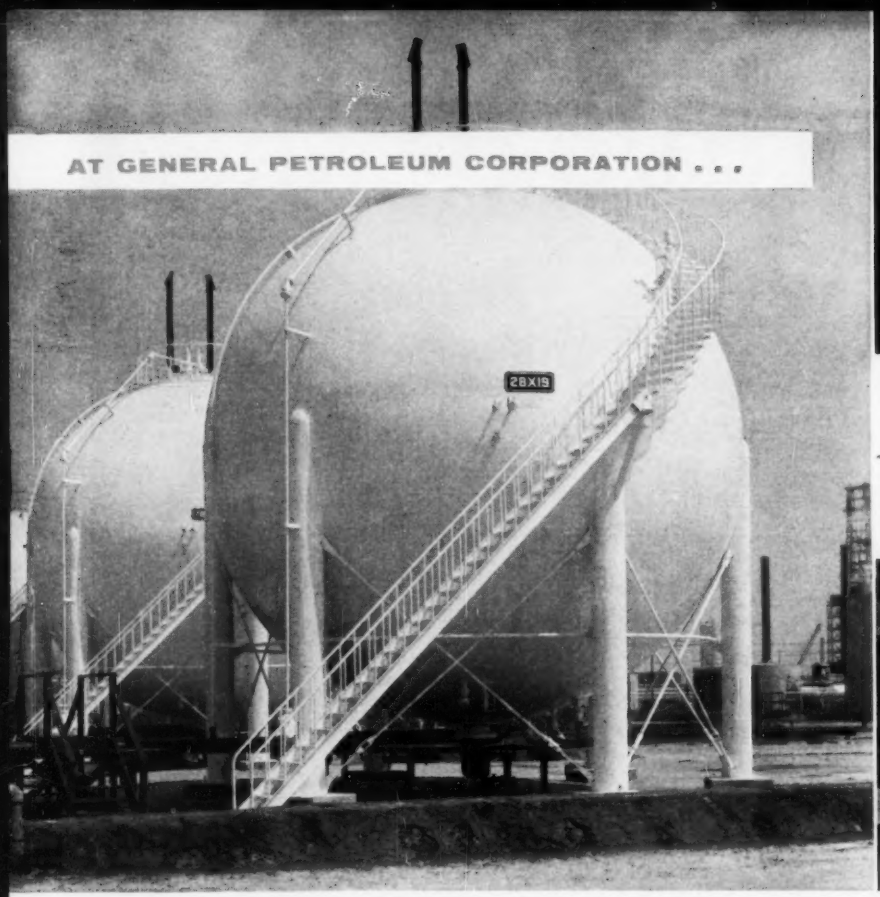

Portable X-ray unit used by CB&I to inspect welded seams on field erected work.

Two 31-foot diameter Hortonspheres® designed for 250 lbs. per square inch pressure, store propane at Company's Torrance, California refinery.

Multiple point potentiometer is used to electronically record the temperatures on various points of the structure during stress relieving.

Hard Working HORTONSPHERES® stress relieved and X-rayed in the field

To meet a specific set of customer requirements, these high pressure, 2,778-barrel capacity Hortonspheres were fabricated at CB&I's Salt Lake City plant and then stress relieved and X-ray inspected *after* they were erected for General Petroleum Corporation's refinery.

Field X-ray and stress relieving facilities are typical of the many highly specialized metallurgical techniques and equipment which CB&I has pioneered and put to work on structures that *work* rather than merely *serve*.

Such facilities point up the many "extras" you get when you specify CB&I . . . the engineering service and attention to metallurgical details that mean a *lot* in today's complex refining operations.

Write your nearest CB&I office for the brochure: *The Evolution of the Oil Storage Tank.*

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Engineering . . .
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***Welded steel structures* serve better and last longer with CB&I coordinated services.**

reported that, as of December 15, contributions to the union's emergency "war chest" totaled $232,487, slightly more than one-fourth of the $5-per-member goal.

Money is being disbursed promptly to striking members, the newspaper said, adding in a plea to members: "More is urgently needed for nearly 3,000 OCAW members who have been on strike since last July."

Domestic Crude-Product Exports Drop in November

U.S. exports of crude and products dropped sharply in November to 149,000 bpd from 205,000 in October and 274,000 bpd in November 1958, according to Bureau of Census statistics. Other November items follow:

- Crude (131,938 barrels)—United Kingdom 85,983, Japan 45,955.
- Blending agents (11,965 barrels)—Canada 11,572, Belgian Congo 393.
- Aviation gasoline under 90 octane (1,573 barrels)—Canada 786, Mexico 100, Guatemala 125, Salvador 274, Bahamas 26, Ecuador 262.
- Petroleum Coke (63,160 long tons)—Canada 29,318, Norway 3,221, United Kingdom 3,216, Belgium 20, France 1,000, Italy 10,869, Yugoslavia 2,953, India 1,135, Japan 11,428.

NPC Appoints Committee On Refinery Maintenance

A special committee on petroleum refinery maintenance and chemical requirements has been named by the National Petroleum Council to study maintenance supplies and process chemicals needed to keep refineries operating under short-range emergency conditions. The committee will be headed by Everett Wells, president of Ashland Oil & Refining Co. Harry E. Jacobs, refining technologist in the Interior Department's Office of Oil and Gas, will serve as government co-chairman of committee.

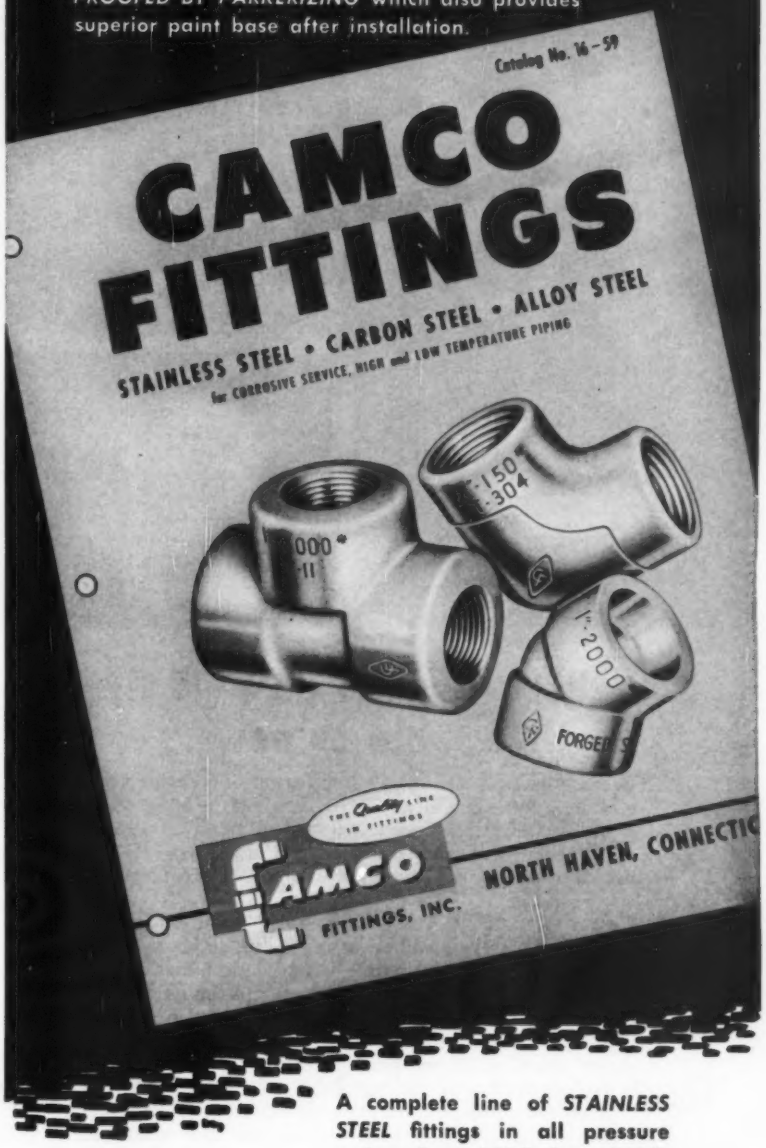
Walter S. Hallanan, chairman of NPC, said the study will be concerned with continuing operation of refineries under short-range emergency conditions which might exist before national organization could be effective. All refineries will be surveyed. Each will be asked to review its maintenance materials requirements and its normal process chemicals requirements.

Increase in Motor-Fuel Tax Said to be Planned By Ike

A motor-fuel tax of five cents per gallon is to be recommended to Congress by President Eisenhower for the interstate highway building program, according to officials of the Bureau of Public

now available . . .

FORGED STEEL screwed and socketweld pipe fittings (2000# thru 6000# rating) with all surfaces RUST PROOFED BY PARKERIZING which also provides superior paint base after installation.



A complete line of STAINLESS STEEL fittings in all pressure ratings from 150# thru 6000#.

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FILL IN AND MAIL TODAY!

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☐ Catalog covering complete line.
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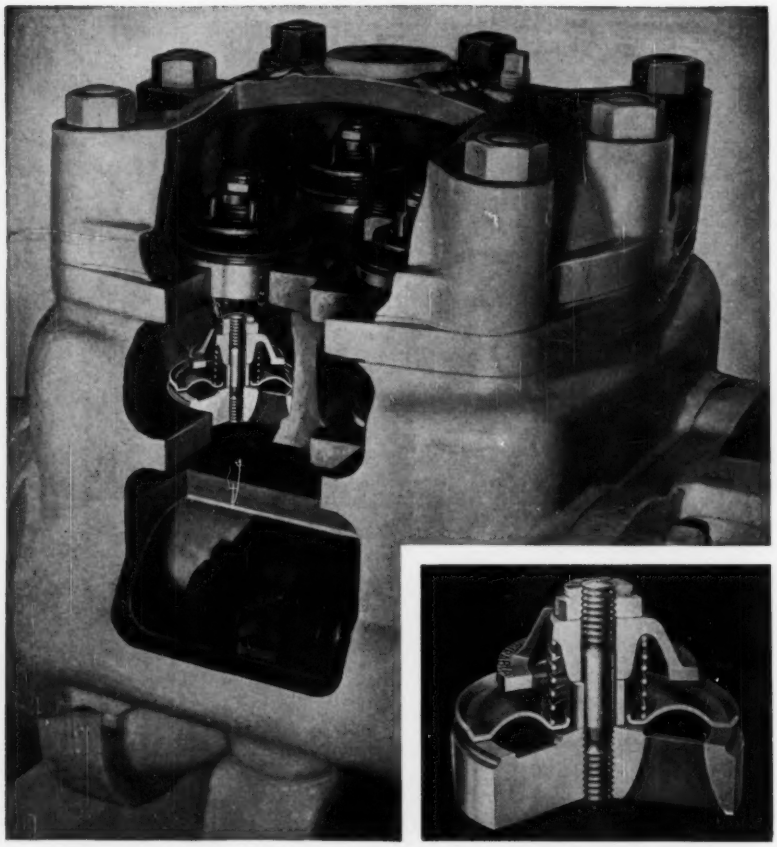

The valve for reciprocating pumps . . . old or new

Because they offer a happy combination of dependability, efficiency and extra life, DURABLA Valves are a credit to any reciprocating pump. Mechanically and metallurgically speaking, they will operate freely under temperature-pressure extremes, with highly corrosive fluids and in any position.

In a DURABLA Valve Unit, only "point contact" is made by the valve member on the sleeve, so it can't bind or hang-up. Due to its unique arched design, neither will it warp. The new V-7* taper-locked stud can be screwed down tight into the seat without any possibility of galling or breakage. And a self-locking nut and "drop-on" guard assure quick and easy inspection of working parts —without stud or seat removal.

Standard equipment on many new pumps, DURABLA Valve Units are also used throughout the world to re-valve older pumps. They come in fifteen sizes, designed to meet over 300 variations in installation requirements.

Write for new booklet PR10.

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114 Liberty Street, New York 6, New York

DURABLA®

DM-34

Happenings . . .

Roads. The President may also ask for an extension of last year's one-cent-per-gallon boost, which expires in June, and drop back to three cents. Reaction from key members of Congress has been adverse. Representative Frank Ikard (D-Texas) of House Ways and Means Committee reportedly feels the measure will not go through. Ikard pointed out that Congress acted only at the last minute in approving last year's scaled-down increase. A five-year 1.5-cent hike was requested, and a two-year one-cent boost granted.

The President also faces the problem of inducing Congress to boost taxes just before major elections. Congressional Democrats are expected to offer more resistance to Republican proposals this year.

Bureau of Public Roads officials say the proposed increase would provide an additional $310 million annually to the highway trust fund, and would put the program closer to the original building schedule.

Government sources report that the White House will ask for the increase to meet pressure from many state governments dissatisfied with the cutback entailed in financing the formula worked out in 1959 by Congress. The formula permits federal outlays to the states of $1.8 billion in fiscal 1961, and $2 billion in 1962.

Chemical Industry Posts Big Sales Increase in '59

The nation's chemical industry posted a sales increase during 1959 of at least $1.6 billion over the previous record year, 1957, for an estimated total of $25 billion. The new record was established despite the steel strike. Continued gains are forecast for 1960 with some chemical industry spokesmen predicting that sales in the next 12 months may total as much as $28 billion.

The 1959 sales of $25 billion represent a 6.8 percent increase over the previous record of $23.4 billion set in 1957. Chemical industry sales in 1958 were $23.2 billion, down slightly.

Petroleum-Product Demand In U.S. Rises in 1959

Demand for petroleum products in the United States during 1959 rose well over four percent to an anticipated record high of 3.47 billion barrels, according to Frank M. Porter, president of API. He estimated that total demand—which includes exports—hit a new peak of 3.56 billion barrels. Exports themselves were expected to drop 16 million barrels to about 84 million barrels.

Calculated on a daily average basis, domestic demand reached 9.52 million barrels, compared with 9.1 million bar-

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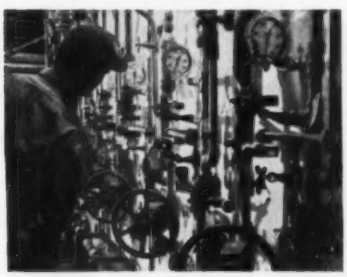
Why external recalibration is important to users of industrial thermometers

Sometimes it is necessary to recalibrate thermometers in industrial installations due to severe shock from rough handling, or to calibrate for extreme accuracy at any point on the scale for special work range.

To recalibrate the ordinary bimetal thermometer, you must remove the dial glass and move the pointer by hand. You will achieve the desired recalibration of course, but a number of undesirable things may also result. First of all, the instrument's air-tight seal is automatically destroyed in the removal of the dial glass. Secondly, in forcing the pointer, the pointer shaft may become bent or twisted.

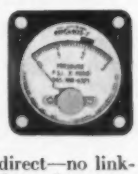
Should the pointer shaft become bent even slightly, it can cause the pointer to stick due to improper alignment of the bimetallic shaft on its bearing surfaces. The obvious result, of course, will be inaccurate readings and necessary repair or replacement of the instrument. *None* of these things can happen with the RMC external recalibration device.

A simple dial-reset screw, located on the back side of RMC industrial thermometers, permits recalibration without opening the instrument in any way. This external recalibration feature is *exclusive* with RMC, along with true dry-air hermetic sealing.



SHIPPINGPORT, Pa.—Heavy-duty dial thermometers play an important role in the operation of the world's first full-scale atomic-electric generating station devoted exclusively to civilian needs. These thermometers, manufactured by RMC, can be recalibrated externally. The plant is a joint project of Westinghouse Electric Corporation, Atomic Energy Commission and Duquesne Light Company of Pittsburgh.

RMC high pressure gauge, developed for missiles, now available to industry



RMC-LINDSAY PRESSUREGAUGES indicate pressures in ranges 0 to 1,000 psi., up to 0 to 15,000 psi., with retard scales available. Multiple coil, helical Bourdon tube type, with pointer attached direct—no linkages or pivots. Can withstand extreme shock, vibration, temperature, or overpressure and maintain consistent accuracy.

Write, wire or phone—tell us your requirements for indicating instruments, and let RMC engineering skill go to work for you. ROCHESTER MFG. CO., 38 Rockwood St., Rochester 10, N. Y.

This maintenance engineer is recalibrating an RMC bimetal dial thermometer by means of the exclusive RMC *external* dial reset screw—a simple on-the-job operation with RMC thermometers.

RMC external recalibration device saves thermometer's hermetic seal

With this *external* dial reset screw you can recalibrate your RMC thermometer easily and safely, should it ever be necessary. The all-important hermetic seal cannot be destroyed and there is no chance for damage to the critical pointer shaft. You get the *only* bimetal industrial thermometer that provides for *external* recalibration when you specify RMC.

RMC

ROCHESTER MANUFACTURING CO., INC.
38 ROCKWOOD STREET • ROCHESTER 10, N.Y.

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

REPRESENTATIVES IN ALL PRINCIPAL CITIES

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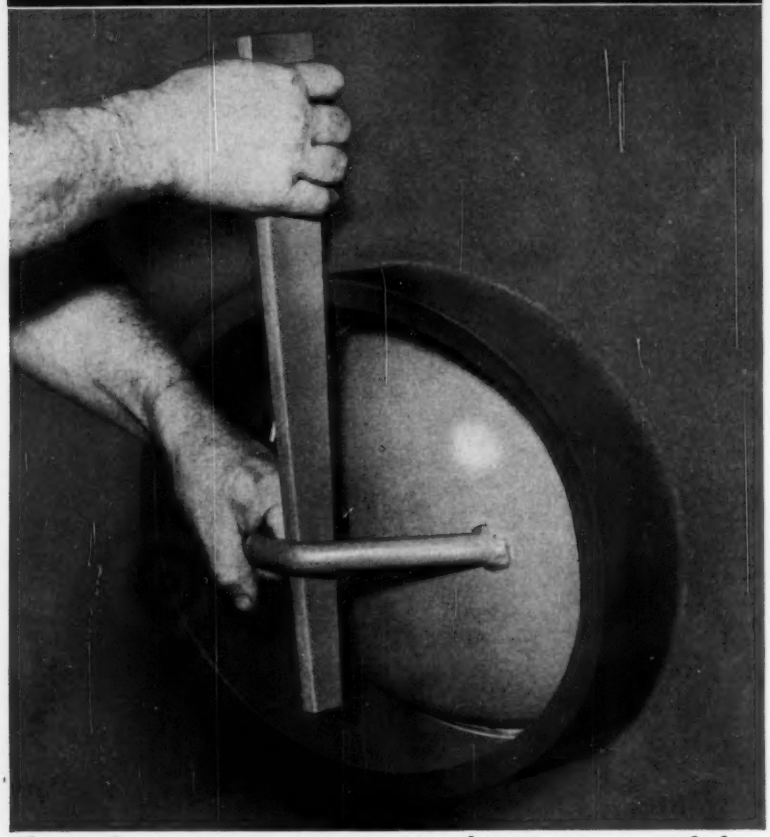
NEW LENAPE WEDGE MANWAY* Eliminates Bolts and Yokes



This revolutionary, new manway is not only easier to open and close, but is actually more economical than conventional bolted covers. Noted for its simplicity, the Lenape Wedge Manway assembly is a unique combination of only three metal parts—ring, cover and key wedge, plus a standard gasket, and is supplied as a "package" assembly.

FAST, SIMPLE OPERATION—As illustrated, to close the manway you insert the key wedge under the cover handle and over the opposite ring wall. Then, merely tap the wedge gently with a hammer until a tight seal is secured. That's all there is to it. Troublesome bolts and yokes are completely eliminated. Uniform gasket loading is assured.

To open, you just tap out the wedge and remove the cover—all in a matter of seconds.

Write today for full details and prices on the amazing new Wedge Manway Assembly—another Lenape exclusive.

**Patent pending*

See our standard line of pressure vessel connections on pages 438-439 in the 1960 Chemical Engineering Catalog.

LENAPE PRESSURE VESSEL CONNECTIONS

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 106 WEST CHESTER, PA.
RED MAN PRODUCTS

Happenings . . .

rels in 1958. Total demand averaged 9.75 million bpd in 1959, against 9.36 million in the previous 12-month period.

Domestic supply averaged 7.9 million bpd, compared with 7.52 million in 1958. Total supply—including imports—averaged 9.65 million bpd. This is about 96,000 barrels above 1957, which was the peak year for total supply. Of the 1959 total, imports of all oils contributed 1.74 million bpd, up 40,000 from 1958.

Output of natural gas liquids, which fell slightly in 1958, will have shown a gain in 1959 to a record high of more than 319 million barrels, Porter predicted. With U.S. crude production registering an increase to 2.57 billion barrels (from 2.45 billion in 1958) the total domestic output of liquid petroleum in 1959 amounted to 2.89 billion barrels.

Chase-Manhattan Bank preliminary reports indicate that oil companies continued to invest heavily in the future. The reports show capital expenditures in 1959 rose some $200 million over the 1958 level to $5.5 billion. This brings the total amount that oil men have invested in capital expansion and development since the end of World War II to more than $61 billion.

Motor fuel production hit a new peak of 1.49 billion barrels, while demand rose to 1.48 billion barrels for the 1959 period. Production of distillate fuel for home and industrial use rose to a record 681 million barrels with consumption reaching a new high of 684 million barrels—up more than four percent over 1958.

The industry's year-end inventories of its four major products recorded a drop for the second straight year. Other refined product stocks were also down. Crude oil stocks showed a decline from 262 million barrels to 244 million barrels. Total crude and refined inventories decreased from 789 million to 753 million barrels. It is to be noted, however, that much of these stocks are working inventories and therefore unavailable.

Operable refining capacity decreased to 9.8 million bpd by year-end (9.8 million on Dec. 31, 1958), but throughput rose to 2.9 billion barrels, or an average of 7.98 million bpd. This is 341,000 bpd over 1958.

Survey Shows Chemical Company Overseas Interest

Nearly 50 percent of the Manufacturing Chemists' Association's member companies are engaged in, or directly interested in, foreign operations, according to a recent MCA survey. It is estimated that 15 percent of the 1959 capital outlay by U.S. chemical firms will be or has been for plants and facilities abroad.

In announcing formation of MCA's new International Operations Committee, General John E. Hull, MCA president, discussed the pros and cons of chemical operations overseas. He advised careful assessment of operating conditions in

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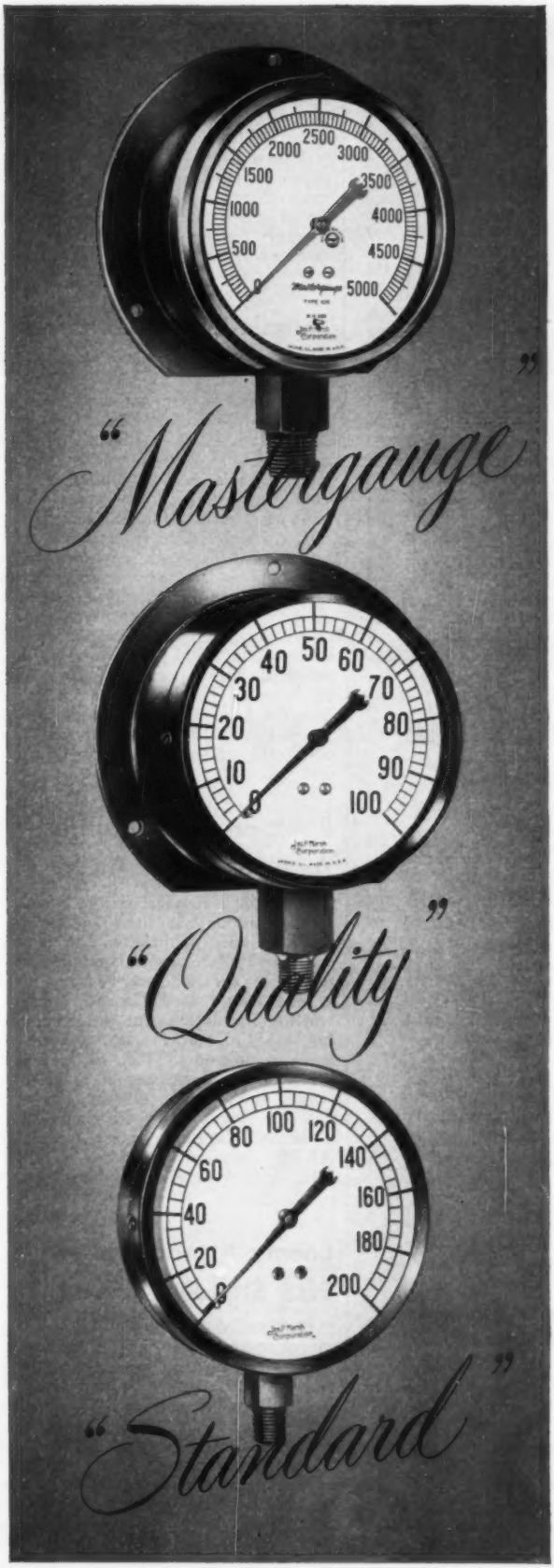

What pressure gauge for your particular need?

The clear-cut economical answer to your specific gauge problem is right here in the Marsh line. It is here because the Marsh line contains the world's most complete range of gauges in the three broad brackets of gauge applications.

THE "MASTERGAUGE" GROUP...for those extreme services that demand the ultimate in gauge precision, accuracy and stamina.

THE "QUALITY" GROUP...also for tough conditions, but less severe than the conditions served by the "Mastergauge" Group.

THE "STANDARD" GROUP...for the general run of pressure gauge services.

While these three brackets run a wide gamut of prices, the difference between them is not so much a matter of *grade* as a matter of *kind* and *purpose*. All gauges in all groups reflect Marsh precision and quality. Collectively they cover practically every conceivable gauge requirement.

The answer is in the catalog...but if you have a special problem let our engineering department work with you to select the most efficient, most economical solution to your problem.

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In stock at your nearest Supply House

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"THE STANDARD OF ACCURACY"

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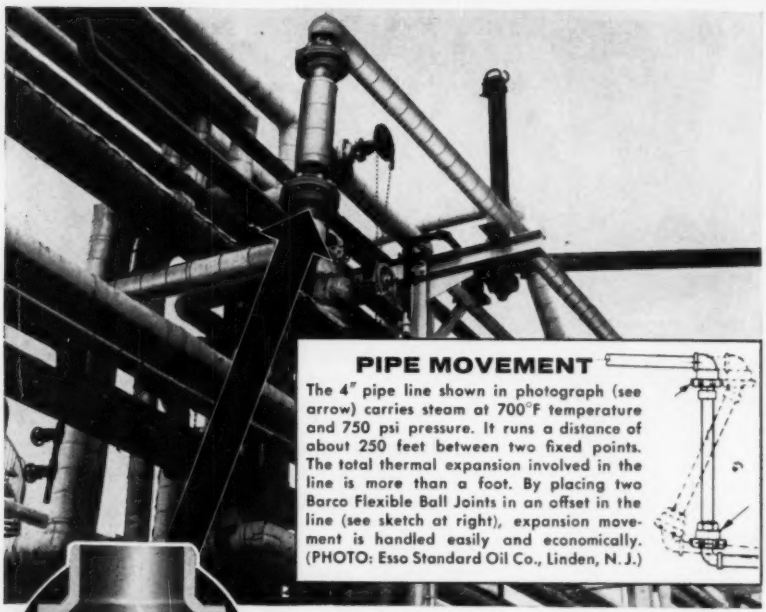
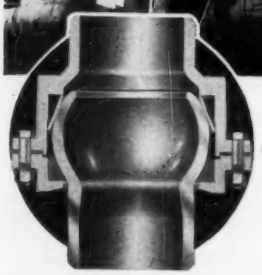
How Refinery Handles 700°F. STEAM . . . PIPE EXPANSION



PIPE MOVEMENT

The 4" pipe line shown in photograph (see arrow) carries steam at 700°F temperature and 750 psi pressure. It runs a distance of about 250 feet between two fixed points. The total thermal expansion involved in the line is more than a foot. By placing two Barco Flexible Ball Joints in an offset in the line (see sketch at right), expansion movement is handled easily and economically. (PHOTO: Esso Standard Oil Co., Linden, N. J.)



BARCO HT (HIGH TEMP.) Flexible BALL JOINTS

SAVE VALUABLE SPACE

ADVANTAGES:

SAVE SPACE—Barco Ball Joints are used to perform functions similar to U-bends or pipe loops—But with much less space required and often LOWER COST.

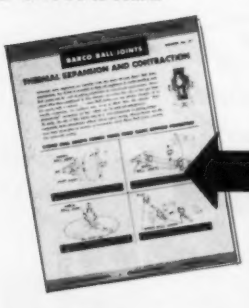
NO PRESSURE THRUST—Expensive anchoring or bracing not required to hold piping in place or in line.

HIGH TEMPERATURE, PRESSURE—Wide choice of materials in new Barco HT Joints.

SIMPLE—Easy to solve virtually any problem with aid of two or three Barco Joints.

The Barco HT (High Temperature) Flexible Ball Joint is a new development. It is *the key* to solving many PIPE EXPANSION PROBLEMS where high temperatures and pressures are encountered. The outer sealing gasket is a special, high temperature ring. The inner take up ring is self-adjusting to thermal expansion and maintains tight sealing action without building up high resistance (friction) to turning or angular flexing. HT joints can be supplied in sizes from 1" to 12", angle or straight, and can be fabricated from materials to withstand as much as 1000°F, 1200°F, or even 1400°F, under certain conditions.

Local Barco Field Engineers will be glad to give you full information and recommendations. Call or write today.



Send for this BULLETIN 31

"How to Solve Piping Flexibility Problems". Complete with piping layout drawings and illustrations. Shows how to cut costs, save time, and do a better job!

PRODUCTS BACKED BY EXPERIENCE BARCO FOUNDED 1908

BARCO MANUFACTURING CO.

5428 Hough Street • Barrington, Illinois

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints

In Canada: The Holden Co., Ltd., Montreal

Happenings . . .

terms of political, social, and economic influences in the country concerned. But, having advised caution, he saw in overseas operations an opportunity for chemical manufacturers to break into tariff-protected markets, to create outlets for raw materials and intermediates produced in the United States and to create sources of materials in short supply in this country.

Sample-Distribution Service Reported On by the NBS

The National Bureau of Standards is currently distributing 60,000 samples of standard materials a year to other laboratories for use in controlling chemical processes and in maintaining the accuracy of apparatus and equipment. A total of more than 600 different standard materials are available from the Bureau—principally chemicals, ceramics, metals, ores, and radioactive nuclides. All are certified either for chemical composition or with respect to a specific physical or chemical property such as melting point, viscosity, or index of refraction. These standards make possible uniform measurements of heat and temperature, define the colors of paints, and calibrate instruments that control the composition of metals and motor fuels.

Book on ChE Faculties Available from AIChE

"Chemical Engineering Faculties", ninth edition, has been published by AIChE. This publication lists a wide variety of information about the departments of chemical engineering in the United States and Canada, such as whether the department is accredited or not, types of graduate work offered, degrees granted in 1958-59, names and degrees of the departmental faculty, and names of placement officers. The publication is sponsored by the Chemical Engineering Education Projects Committee, AIChE. It may be obtained free from AIChE, 25 West 45th St., New York 36.

Enemy-Attack Drill for Esso Standard Executives

Because of the possibility of enemy attack, once a year the headquarters of Esso Standard Oil Co. shifts for a day to a rural scene 30 miles from New York. This shift is a drill to make sure that Esso's defense plans will work in an emergency. The alternate headquarters is operated by executives who live nearby, so that men who can reach the site will be able to carry on the company's business. Higher executives who live farther away can't be counted upon to reach the headquarters through the chaos that

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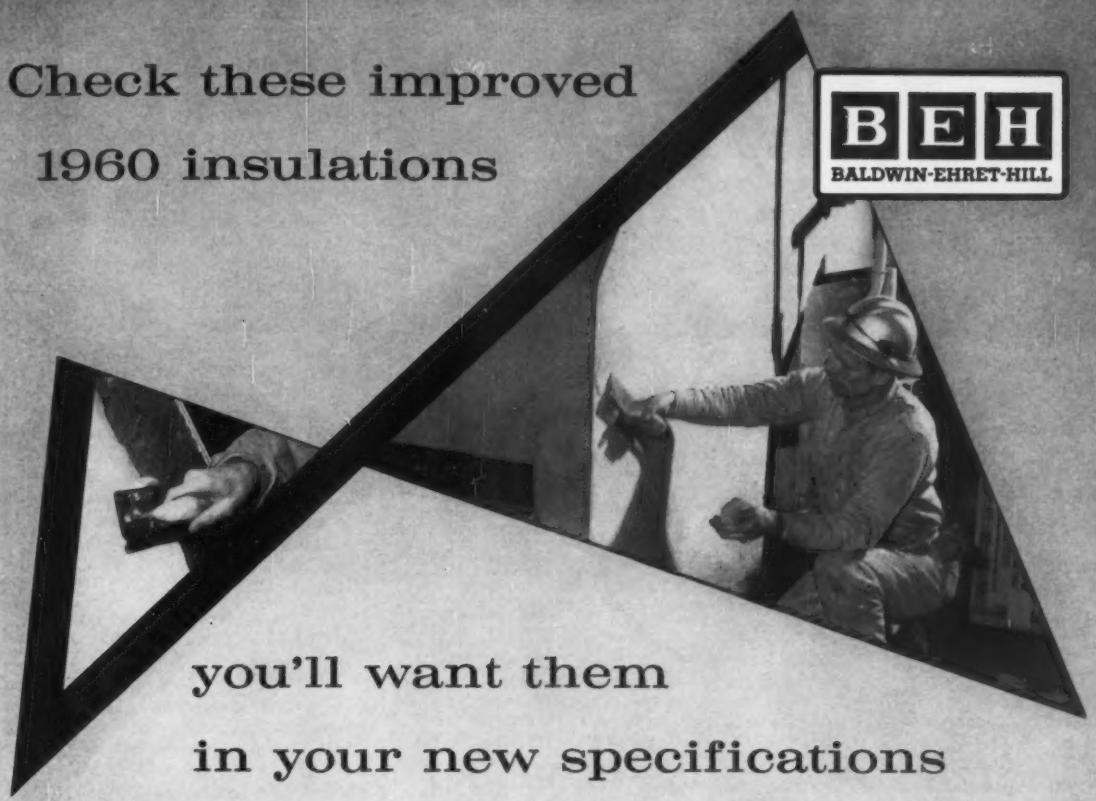
Check these improved
1960 insulations



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BALDWIN-EHRET-HILL

you'll want them
in your new specifications

Take a Fresh Look at **SUPER POWERHOUSE**
Insulating—Finishing Cement

You readily see there is an improved whiteness—Super Powerhouse dries *super* white. It withstands rain, sleet and snow after initial set—no redoing jobs because the weatherman erred. It has outstanding coverage, insulates and finishes in one coat yet performs better than many insulating cements.

New advantages such as these make it imperative to check your insulation specifications before rewriting them for a new project. Baldwin-Ehret-Hill offers you the complete line—a selection of over thirty different specialized insulation products for service from sub-zero to 1900 F. Each is designed to give you greater efficiency, easier application and lower installed cost. To bring your specifications up to date, write for our new 1960 catalog or see it in your Sweet's file.

NOW IS THE TIME TO UPDATE YOUR SPECIFICATIONS WITH . . .

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THE COMPLETE LINE OF INSULATIONS for use SUB-ZERO TO 1900 F.

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Allflex

STAINLESS STEEL

"MNH" FLEXIBLE CONNECTORS

A NEW stock answer to pipeline problems caused by rigid connections.

- Dampens Vibration
- Compensates for Misalignment
- Permits Offset Movement
- Absorbs Expansion

With ALLFLEX Stainless Steel Connectors you get:

- CORROSION RESISTANCE . . plus
- PRESSURE RESISTANCE . . plus
- HEAT RESISTANCE . . plus
- FLEXIBILITY

Also available in Monel, Bronze and Steel.

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THESE STOCK SIZES
¼" ⅜" ½" ¾"
1" 1¼" 1½" 2"
IN THESE STOCK LENGTHS
12" 18" 24" 30"
36" 48" 60"
SHIPPED FROM FACTORY SAME DAY ORDER IS RECEIVED.

Also available in all standard sizes thru 16", in any required lengths, and with any special or standard end fitting or flange connections. Send your problems to Allied's Engineering Department; Let us suggest the best solution for your flexation problems.

ALLFLEX Standard Stainless Steel Connectors are sold through leading Industrial Distributors. If not available locally—*REMEMBER* THEY CAN BE SHIPPED FROM FACTORY SAME DAY ORDER IS RECEIVED

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Voss Valves are made to specification, machined from solid stock (not cast)—using best alloy steels; for corrosion condition—stainless steels, such as 410, 18-8 or non-ferrous alloys—monel, inconel, etc. Plates are machined (not stamped) and ground for precise close tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. Springs of heavy rectangular sections and large diameters add to dependability and safety.

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- normal discharge temperature
- quiet, vibration-free
- utmost safety
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For detailed proposal send name, bore, stroke and speed of machine.

J. H. H. VOSS VALVES REG. U.S. PAT. OFF.

J. H. H. VOSS Co., Inc.
785 East 144th Street,
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Happenings . . .

would follow an attack.

Fifty bedrooms and baths in the converted 60-acre fenced rest home could accommodate 65 persons. Today, three persons staff the lonely house, keeping up-to-date the microfilmed records stored in the underground vault.

But Esso has found another use for the headquarters. Staff meetings are held there, saving the cost of hotel accommodations and removing the distractions that sometimes prevent maximum productivity at in-city meetings.

The headquarters is the hub of an emergency communications network, including a three-position telephone switchboard connected directly to other Esso facilities and to Washington, teletypes, and two-way radio circuits.

Three cadres of executives and staff are assigned to emergency jobs, and should world tensions worsen sharply they would staff the headquarters on a rotating basis for one week at a time.

Unrestricted Grants Given To Colleges by Creole

Unrestricted grants to 35 U.S. colleges and universities amounting to $34,800 have been announced by the Creole Foundation, established in Venezuela by Creole Petroleum Corp. to support educational, scientific and cultural activities there. Donations, ranging from $500 to $3,500, are being awarded as collateral grants to U.S. institutions at which 58 scholarship students from Venezuela are currently enrolled.

Esso Education Foundation Receives Service Award

The Esso Education Foundation has received Alpha Kappa Psi Foundation's annual award for distinguished service to higher education. The bronze tablet was presented to David A. Shepard, executive vice president of Standard Oil Co. (New Jersey) by Dr. Joseph H. Taggart, dean of the Graduate School of Business Administration, New York University. The presentation was a feature of Education Day at the 64th Congress of American Industry, sponsored by the National Association of Manufacturers.

The Esso Education Foundation was established in 1955. During its four years of existence, it has made grants totaling more than $5.5 million to privately-supported colleges and universities. A feature of the foundation's program is the number of unrestricted grants—279 in the college year 1958-59 totaling $721,500—made to colleges and universities for undergratuate education. This action followed a survey of educators who pointed out that unrestricted grants which can be used for faculty salaries or other operating expenses are the most helpful and flexible type of educational aid. The founda-

Layne pumps top more producing water wells

Layne Pump Design, manufacture and installation are only part of the complete water service offered by the Layne organization. Other services include: Initial surveys, explorations, recommendations, site selection, foundation and soil sampling, well drilling, well casings and screens, gravel wall wells, construction of water systems, complete research staff and facilities, maintenance and service, chemical treatment of water wells, water treatment. *Write for Bulletin No. 100.*

WORLD'S LARGEST Layne WATER DEVELOPERS

LAYNE & BOWLER, INC., MEMPHIS

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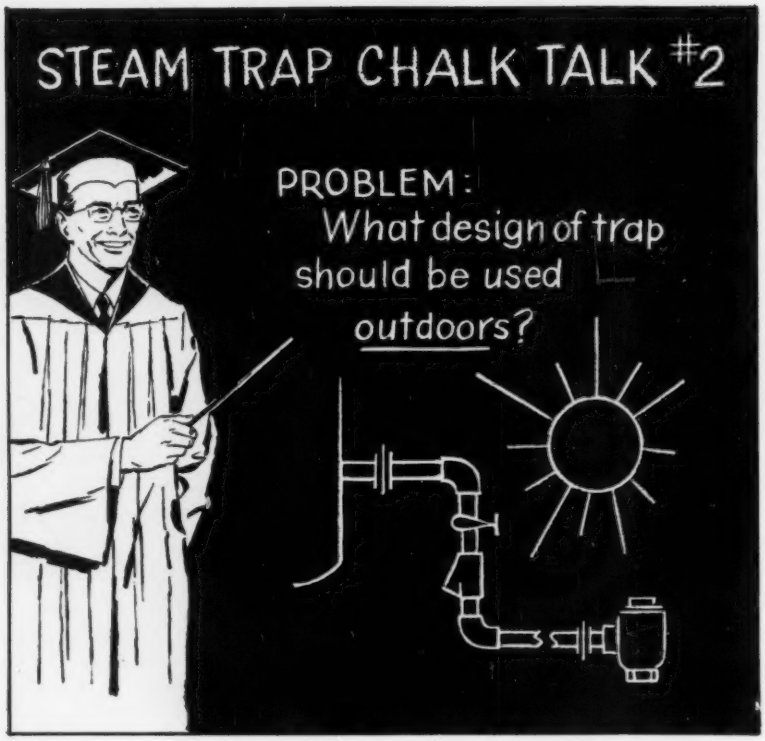
LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD



- First, use Anderson Quik-Flex thermostatically designed steam traps. These traps have no pockets in which water will collect and freeze. An open pipe on the discharge side provides constant drainage and eliminates any maintenance during freezing temperatures.

Second, use a cooling leg of at least three feet. Thermostatic traps operate on temperature differential, and sufficient piping must be provided for the condensate to cool.

Third, install the strainer in a down position. Strainers in horizontal positions collect condensate which freezes and breaks the strainer body during cold weather.

Anderson Quik-Flex Steam Traps are built especially for outdoor service. Guaranteed freeze-proof for two years, they provide a lifetime of trouble-free, freeze-proof draining of condensate from steam lines. Mail coupon for complete details.

A TRAP FOR EVERY PURPOSE

THE V. D. ANDERSON COMPANY
division of International Basic Economy Corporation
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Please send without obligation your catalog describing Anderson freeze-proof Quik-Flex Thermostatic Steam Traps.

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ANDERSON QUIK-FLEX

Happenings . . .

tion also made grants totaling $528,630 to privately-supported colleges and universities to stimulate science teaching at the elementary, secondary, undergraduate, and graduate school levels.

December Octane Ratings Reported By Ethyl Corp.

Gasoline on sale at service stations in December showed national weighted averages of 99.3 octane number for premium and 92.4 octane number for regular, according to the latest monthly survey of antiknock quality compiled by Ethyl Corp.

The premium average was unchanged from November while the regular average was 0.2 octane number higher. For 1959 as a whole, the premium average gained 0.5 octane number while the regular average increased 0.9 octane number.

Average tetraethyl lead contents in December were 2.43 ml per gallon of premium gasoline and 1.62 ml per gallon of regular gasoline.

Revised Oil-Import Program Announced By Interior

The new mandatory oil import program for the period January 1 through June 30 has been announced. Under this program, total imports of petroleum both controlled and uncontrolled, into the United States are estimated at 1,727,000 bpd. Uncontrolled imports as in the previous program, include oil for ships bunkers, oil for re-export, and overland imports from Canada.

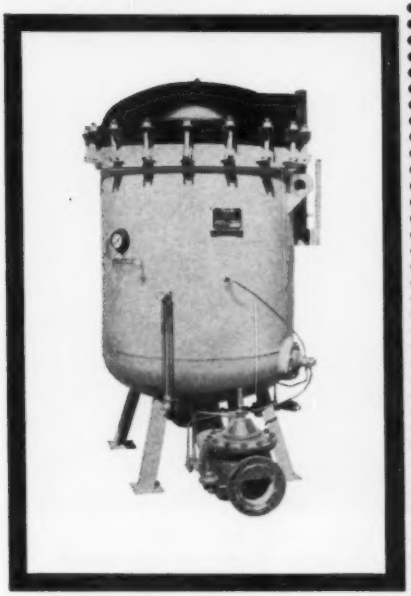
With total imports for the first half of next year expected to be about 1,727,000 bpd, domestic crude oil production during the period should average about 7,400,000 bpd. This level compares to the depressed rate of about 6,900,000 bpd during the current six-month period and a December rate of production of about 7,100,000 bpd. Thus, providing demand continues to increase as expected, domestic crude oil producers, in the first half of 1960, can look to an increase of approximately 500,000 bpd over the last half of 1959 and 300,000 bpd over current production.

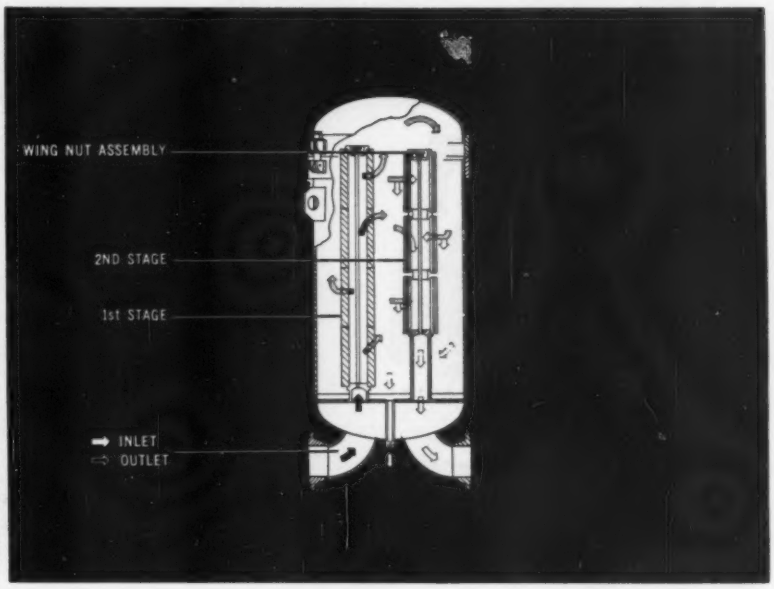
Changes in import levels for the first half of 1960 will be as follows:

(1) The limitation of all controlled imports except residual fuel into Districts I-IV is continued at 9 percent of total demand. In accordance with the expected increase in this demand these imports have been increased proportionately 35,000 bpd.

(2) Under the revised program total imports into District V will be reduced about 13,000 bpd. This reduction results from consideration of all Canadian crude oil imports as part of the domestic supply, partially offset by an estimated increase in the difference between domestic supply and demand in District V. The

specify FRAM-WARNER LEWIS EQUIPMENT





COALESCERS, WATER SEPARATORS, FILTERS FOR PROCESS STREAMS

WHERE WATER AND DIRT ARE PROBLEMS: Fram-Warner Lewis separator/filters are specially designed to remove water and dirt from chemical process streams. The famous Warner Lewis TWO STAGE design units offer wide flexibility of design to meet a variety of process applications. Units remove 90% to 100% of all entrained water with filtration efficiency down to 5 microns.

1st Stage (coalescing-filtering) cartridges remove solids such as dirt, rust and scale and breaks up mechanical emulsions. Finely dispersed water droplets gather together into large water droplets and fall by gravity into the water-collecting sump.

2nd Stage (separating) cartridges are chemically-treated media which completely blocks passage of water yet permits passage of product through cartridges to the outlet.

Two stage design provides positive protection against contaminated products not possible in single stage designs. Replacement cartridges are easily installed and inexpensive.

Write Process Department, Warner Lewis Company for details.

WARNER LEWIS COMPANY
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DIVISION OF FRAM CORPORATION

For more data on advertised products, use Readers' Service Cards, last page.

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

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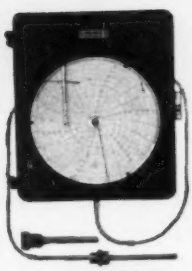
MERCURY ACTUATED
Temperature Indicating
Instruments



RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

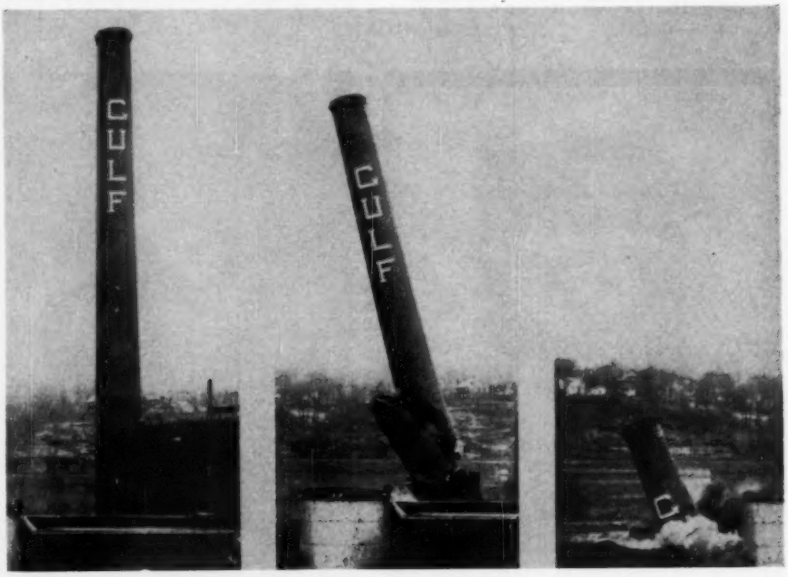
Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

PALMER
THERMOMETERS, INC.
Cincinnati 12, Ohio • MElrose 1500

Happenings . . .

inclusion of all Canadian crude as part of domestic supply was urged by California producers and the IPAA.

(3) An increase of 62,000 bpd over the present allocation for residual fuel oil imported for use as fuel. Residual fuel stocks together with permissible imports and domestic production will be adequate to meet seasonal demands.



Making way for the new is a 300-ton, 135-foot-high brick chimney, part of a refinery once operated by Gulf Oil Corp. on Neville Island near Pittsburgh. The Rust Engineering Co. used explosives to "throw" the chimney perfectly into a hole excavated to catch the toppling structure. Rising on the site of the former refinery will be a new Gulf storage terminal, dispatch building, control tower, warehouses, truck maintenance facilities and barge docks. Completion is set for spring 1960.

Specify POSEY Pressure Vessels

Our record of fabricating high quality steel plate vessels dates back to 1910. We have the experience, the facilities and the engineering know-how to design and fabricate tanks and pressure vessels of all types and sizes . . . of steel or alloy steel . . . for liquid or gas. Manufactured and stamped in accordance with **ASME** code. Let us quote on your next pressure vessel job.

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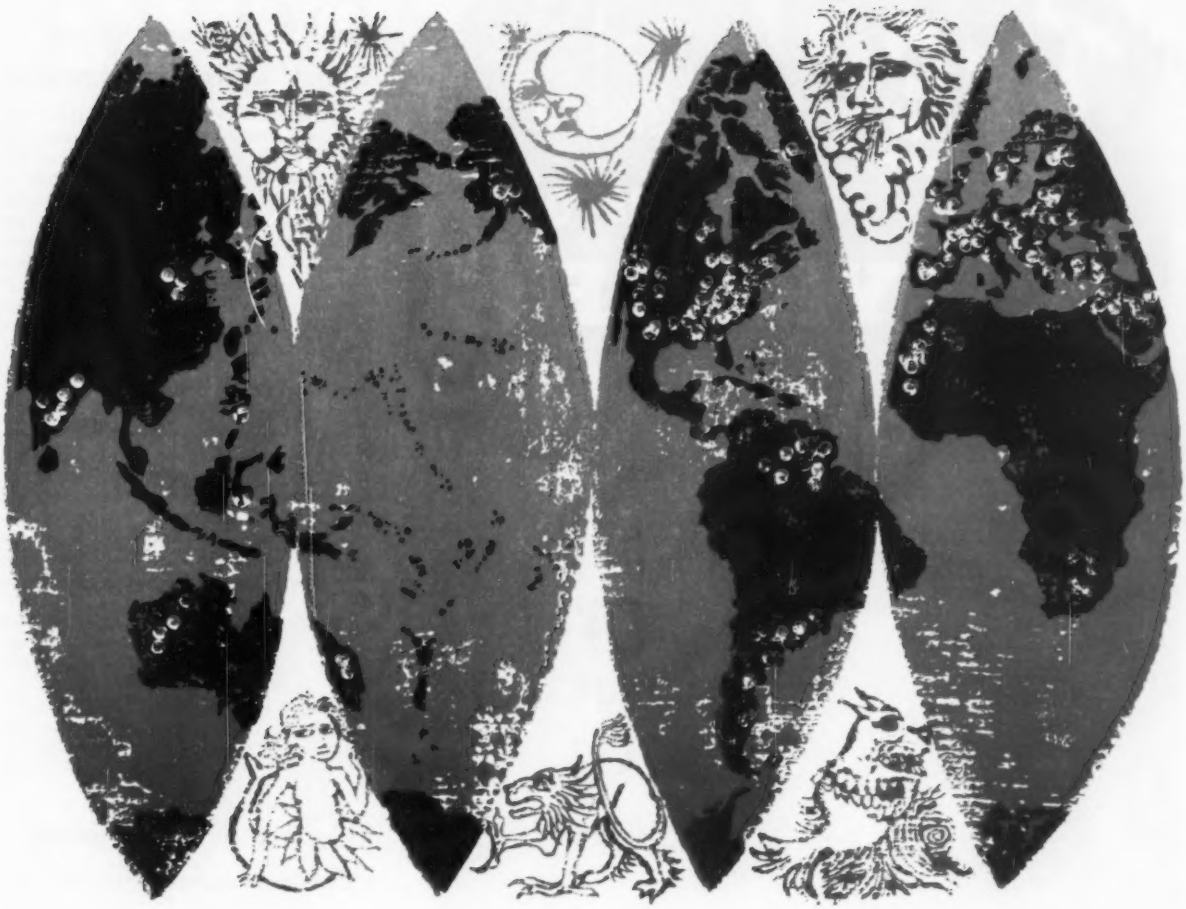

805 reasons a Foster Wheeler plant fits your requirements best

Wouldn't you like to find your new plant running on its scheduled completion date, meeting all specifications, and at a cost within the construction budget? The process industries have come to expect results like these when dealing with Foster Wheeler.

Would you like to see your own process plants handled by designers, engineers and construction men who have successfully put 75 different processes into efficient commercial operation?

And, if you have decided to pioneer a new process, wouldn't you like to have the advantage of Foster Wheeler's long experience with basic processing methods, such as fluidized solids, effluent refrigeration, simplified sulfonation, and efficient heat balancing in chemical operations, etc. This unique experience—plus *procurement knowledge* gained in construction of some 805 large and small plants throughout the world, and *specialized equipment know-how* available through FW's own equipment division—works for you when you use FW design, engineering and construction services.

Get specific information by discussing your process needs and plant requirements with Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.—or write for a copy of the new fully-illustrated booklet describing FW's services.

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For more data on advertised products, use Readers' Service Cards, last page.

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- ALMOST 100% SAFETY AGAINST GALLING AND SEIZING WITH ALL BEARING METAL COMBINATIONS
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Write for your free sample of MOLYKOTE G LUBRICANT today. We will also send you a copy of our new Bulletin 126 which gives complete details. THE ALPHA-MOLYKOTE CORPORATION, 65 Harvard Avenue, Stamford, Conn. Phone FIreside 8-3724. Plants in Stamford, Conn., Munich, Germany and Strasbourg, France.

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278 For more data on advertised products, use Readers' Service Cards, last page.

Happenings . . .

Coal Spokesman Voices 'Shock' at Residual Imports

A National-Coal-Policy-Conference spokesman reports that his group was "shocked" by an increase in the residual-fuel-oil import level for the January 1-June 30, 1960, period. Joseph E. Moody, president of NCPC, said: "We are shocked by this action and plan immediately to ask for a review of this matter and downward adjustment of quotas in line with the facts. Two things must be kept in mind in connection with the residual oil import quotas," Moody said. "Allocations have never been utilized to the allowable maximum, and prices for imported residual oil have not risen."

In a similar vein, Russell B. Brown, general counsel for the IPAA, said in a letter to members that "it should be noted that prices for residual fuel oil have been at depressed levels for the past two years. There has not been, nor is there any indication now, from these depressed prices of any shortage of residual fuel oil.

"While the increase in residual fuel imports is not expected to have any significant effect on the levvel of U.S. crude oil production," Brown said, "these increased imports could prevent a needed recovery in the depressed prices for this product and thereby continue to depress the refiner's total realization from each barrel of crude oil."

Industrial Waste Meeting Held in Chicago, Illinois

Scientific, technical and management representatives of 34 major industries met in Chicago, December 15-16 to discuss last year's major developments to reduce or control industrial wastes flowing into rivers, lakes, and streams of the United States. This was the annual meeting of the National Technical Task Com-

For Safety's Sake

The safety of a worker's fingers —industry's best production tools —is the subject of a new pamphlet published by the National Safety Council. Entitled, "A Simple Do-It-Yourself Project," it deals in a humorous manner with a grim subject—the loss of fingers. "Cartoons, humor, brief words and bright color—these are the ingredients that will make workers read, understand and remember the do's and don'ts for keeping their fingers out of harm's way, at work and at home," the Council said. A single copy of the pamphlet is available free from the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

DU PONT *Petroleum Chemicals* NEWS

Number 100 in a Series of Bulletins for the Petroleum Industry

JANUARY-FEBRUARY 1960

WHAT'S NEW IN DYES?

Du Pont Improved Free-Flowing flaked dyes provide many advantages

ADDITIVES MANAGER

W. E. BETTONEY is now serving as Manager of Additives. In this capacity he is responsible for the sale and technical services for all Du Pont additives other than tetraethyl lead.

Prior to this appointment, Mr. Bettoney served as Technical Manager for the Eastern Region. And before being named to that post, he was assistant director of the Du Pont Petroleum Laboratory.

Mr. Bettoney joined Du Pont in 1946 as an engineer in the Petroleum Laboratory. For several years he was associated with application research on the effects of chemicals on the performance of petroleum products in engines.

Mr. Bettoney is a mechanical engineering graduate of the University of Maine. Before joining Du Pont he was with the Dodge Division of the Chrysler Corporation in Chicago. Mr. Bettoney is a member of the S. A. E. and A. C. S.

Du Pont Oil Colors in flaked form occupy less space.

Du Pont oil colors have been available in either powder or flaked form for some time. Because flaked dyes are virtually dust-free, they have been constantly gaining in popularity. The newest Du Pont flaked dyes are now further improved so that they dissolve more readily than ever. As a result, more and more refiners will find that Du Pont's fast-flowing, fast-dissolving, dust-free flaked dyes are more satisfactory than ever.

Less bulk The flaked form of Du Pont Petroleum dyes takes up approximately half the space of the same dye in conventional, powdered form, thus saving refiners valuable storage space. Furthermore, flaked dyes come in short drums (22 inches high) which are easily handled.

Many colors You can get Du Pont flaked dyes in orange, red and bronze. Blue dye is available in a crystalline form which has the same advantages as flaked dyes. Samples and full details are available now from your Du Pont Petroleum Chemicals representative.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT *Petroleum Chemicals* NEWS

New instrument for studying surface ignition

Engineers at Du Pont's Petroleum Laboratory have announced the development of a new electronic instrument for investigating surface ignition.

Used in any car

This instrument will help provide clues to both better fuels and improved high-compression power plants, since it is now possible to study surface ignition in any automobile by merely installing special pressure-sensing spark plugs in the car's engine. Surgery to the engine is eliminated.

Using a double-tracked recording tape, the new instrument determines the exact time in the cycle when the combustion pressure reaches its peak. Such information is developed for each cylinder.

Transducer at work

Heart of the electronic instrument is a special normal-sized spark plug equipped with a built-in miniature piezoelectric pressure transducer. These plugs can be substituted for standard plugs in most cars.

Variability of the instrument is less than plus or minus one-tenth of a crank-angle degree, or about five millionths of a second at 3200 engine revolutions per minute.

If you would like to know more about the instrumentation and what's been learned through it, write for a copy of "Surface Ignition—A New Look with a New Instrument."

How to keep copper from making trouble

Copper-bearing surfaces can exert a harmful pro-oxidant effect on petroleum products. In helping overcome this, Du Pont Metal Deactivator chelates with copper ions and thus essentially removes them from the reaction.

Another Du Pont product, Du Pont Metal Suppressor, reduces the possibility of copper catalyzed reactions by forming a film on the copper surface which insulates the metal from the petroleum product. Thus, copper strips which have been exposed to Du Pont Metal Suppressor are passive for some time after—even when contacted by products that do not contain the compound. Du Pont Metal Suppressor also works on brass and monel.

CONTINUED *What's new in dyes?*

Du Pont Oil Red A is announced

The most recent addition to the line of Du Pont dyes made expressly for the petroleum industry is Du Pont Oil Red A.

This is an oil-soluble dye for use with gasoline and other petroleum products. It imparts a slightly different shade to gasoline which is generally considered to be 10 to 25 per cent stronger, depending on test procedure used, than conventional reds, such as Du Pont Oil Red.

Two forms Standard packages contain 100 lbs. net. You can get Du Pont Oil Red A in powdered form, shipped in non-returnable 41-gallon fiber drums. Flaked Oil Red A comes in the 24-gallon drum.

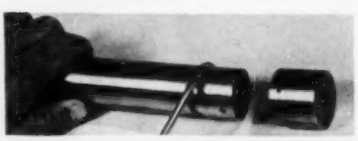
For more information, contact the office nearest you. Please see the listing below.

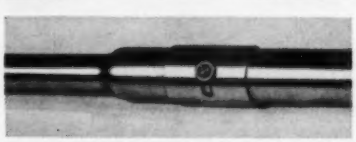
Modified Du Pont Dry-Dye Eduction probe offers many advantages

Until a few years ago, the dry-eduction method of handling dyes was little used. Equipment was not very efficient. Clogging, as well as other difficulties, was an ever-present problem.

Then in 1956, Du Pont introduced the "tube-within-a-tube" design. So successful was this probe that it soon became the most popular dye-handling tool in the industry.

New brass tip Now, after several years of experience, further refinements in the Du Pont design have been made. For example, brass is now used in the tip for increased durability. And the tip can be easily removed merely by flexing the securing clip with a screwdriver.





Improved air inlet The other major change is an improved air inlet which provides for a continuous flow of air as well as for easy setting of the air port to fit individual needs.

This model probe is known as No. WT-503 Du Pont Dye Probe. Your local Du Pont representative can fill you in on availability as well as discuss the possibility of modifying the earlier model with new parts.

Or write for the just-printed Additives Handling Bulletin No. 5.

SALES OFFICES

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Cleveland 15—101 Prospect Ave. ..... MAin 1-3422
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San Francisco 4—111 Sutter St. ..... EXbrook 2-1934
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DU PONT
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Better Things for Better Living
... through Chemistry

Du Pont Tetraethyl Lead and other Petroleum Additives

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-12705

Printed in U.S.A.

mittee on Industrial Wastes, composed of 65 scientists and engineers. The United States Public Health Service was also represented.

E. Hurwitz, director of laboratories, Metropolitan Sanitary District of Greater Chicago, discussed the newly developed process to dispose of sewage sludges, known as wet air oxidation; Gordon E. McCallum, chief, Division of Water Supply and Pollution Control, Public Health Service, Washington, D. C., outlined progress made under the new Federal Water Pollution Control Act; Bernard B. Berger, director of research at the Public Health Service Sanitary Engineering Center, Cincinnati, outlined research progress in industrial and municipal waste disposal; Harry Faber, research analyst, discussed the way in which Federal research grants have aided medicine and public health developments during the year; and Fred V. Doutt, technical advisor, Carolina Division, The Champion Paper and Fibre Co., discussed ways in which employes of industry can help fight water pollution.

Petroleum Sessions Slated For AIEE Winter Meeting

Electrical engineering developments in the chemical and petroleum industries will be surveyed in two symposiums during the Winter General Meeting of AIEE at the Hotel Statler-Hilton, New York, January 31-February 5. Papers scheduled for sessions held February 3 are:

- Application of Accepted Cable Heating Principles to Unequally Loaded Underground Duct.
- New Trends and Wiring Methods in Chemical Industry.
- The Application of Static Switching to the Control of Two 7,500-hp Oil-Fired Combustion Turbines.
- New Developments for Hazardous Locations, Class I and Class II.
- Characteristics of Centrifugal Pumps & Compressors Which Affect the Motor Driver Under Transient Conditions.
- Power Distribution to Refinery Process Units.
- Wire and Cable for Chemical Plants.
- The General-Purpose Analog Computer.

- Changing Times -

Domestic crude consumed in United States or exported in December was estimated by Bureau of Mines at 7.25 million bpd, compared with 6.9 million bpd forecast for November. Included are estimates of total gasoline demand of 3.96 million bpd in December, gasoline yield of 44 percent and crude runs of 8.2 million bpd.

Ashland Oil & Refining Co. has acquired properties of Louisville Refining Co., Louisville, Ky., and its subsidiary, Producers Pipeline, **from Farm Bu-**

Condensing Gasoline for H. L. HUNT

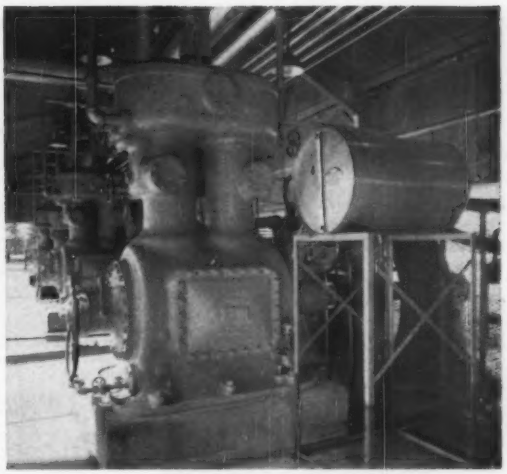


PHOTO BY OIL & GAS JOURNAL

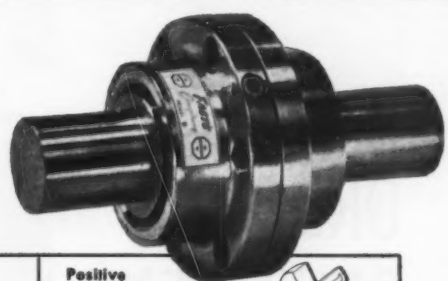
H. L. HUNT, Allen Parish, La., operates four Frick 12" by 12" ammonia compressors, plus a 10" by 10" and numerous shell vessels, in a 10 MMCFD refrigeration oil absorption type natural gasoline plant.

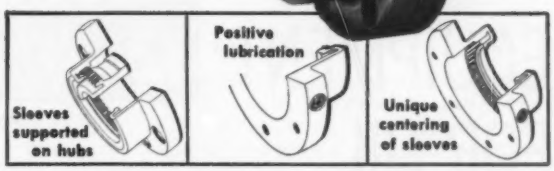
Temperatures range down to –10° F. These compressors were furnished by Kay Engineering Co., Frick distributors at Oklahoma City, Dallas and Houston.

For all types of process cooling, air conditioning, ice making, quick freezing or other industrial cooling, you too can depend on Frick equipment for economical and dependable operation.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA., U. S. A.

FAST'S Model B Coupling





reduces downtime and upkeep for light-to-medium drives!

Now you can profit from the durability and economy of famous Fast's couplings in a smaller and lower-cost version—available in 5 sizes for shafts ½" to 3⅛" in diameter.

The Model B coupling gives you the same features that have made Fast's the world's leading coupling for over 35 years. You get the same trouble-free performance, longer service life and lower maintenance costs. You also get prompt delivery because stocks are on hand to meet practically every need. Free engineering service is also available.

Write today for more details to KOPPERS COMPANY, INC., Fast's Coupling Dept., 6101 Scott Street, Baltimore 3, Maryland.

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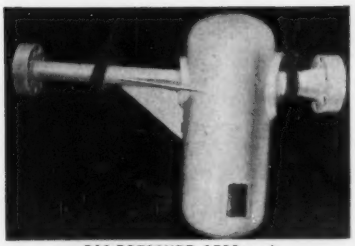
KOPPERS

THE ORIGINAL *FAST'S Couplings*

For more data on advertised products, use Readers' Service Cards, last page.



GAS PRESSURE, 1500 p.s.i.

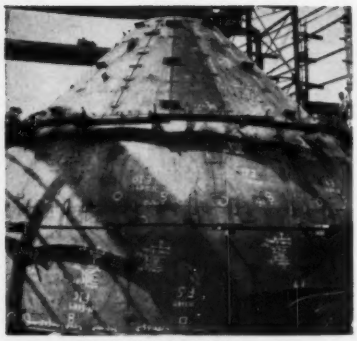
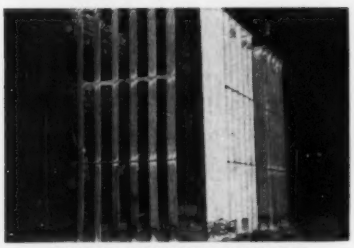
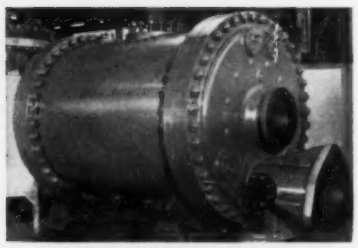


PLATE WORK, 55′ dia. cone

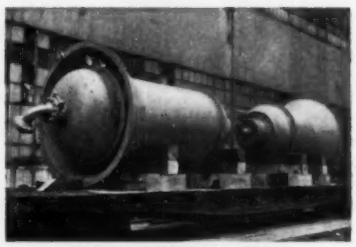
GALVANIZING POT



SPECIAL ALLOY STEEL DEFLECTORS

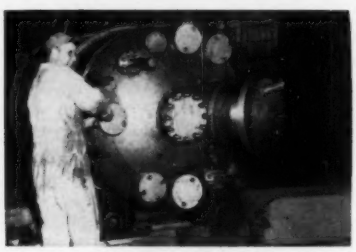


SPECIAL CHEMICAL VESSEL

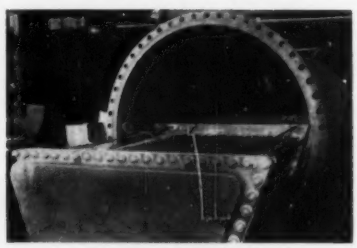


SPECIAL STAINLESS VESSELS

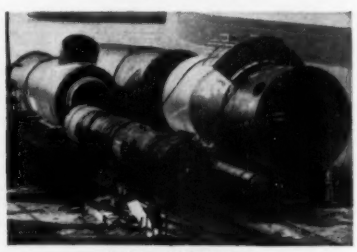
TOWER, 8′6″ dia. x 154′ in length



STAINLESS AUTOCLAVE



SPECIAL CONDENSER



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SUN SHIPBUILDING & DRY DOCK COMPANY

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reau Cooperative Association, Columbus, Ohio. Deal involves 8,000-bpd refinery.

Monsanto Chemical Co. and The M. W. Kellogg Co. have satisfactorily resolved differences over design and construction of methanol plant at Texas City, which included equipment furnished by Linde of Germany.

Senator Morse (D-Ore.), **chairman of Senate subcommittee on Latin American affairs,** made December trip to Buenos Aires **seeking evidence that State Department's oil policies are driving some Latin American countries into accepting Communist credits.** He will prepare memo on Argentina containing recommendations to Senate.

Despite efforts by individual stockholder **to obtain court order halting merger of Humble Oil & Refining Co. with Standard Oil Co. (New Jersey), merger papers were filed** with Texas secretary of state December 1. Stockholder has filed suit questioning legality of merger.

U.S. Supreme Court has upheld in effect NLRB ruling that Quaker State Oil Refining Co. engaged in illegal "lockout" during contract negotiations with local union of OCAW at company's Emlenton, Pa., refinery.

Five-month Los Angeles ban on fuel-oil burning in summer, 1959 measurably improved quality of air over Los Angeles Basin, according to Smith Griswold, air pollution control officer. He recommended that "Rule 62" be continued next summer.

First-year Soviet-Brazil trade movement will be made up almost entirely of crude-oil products and oil equipment, under agreement signed December 11. Value of first-year shipments in each direction—$25 million.

Leonard Refineries, Inc. and Standard Oil Co. (Ohio) will merge January 28.

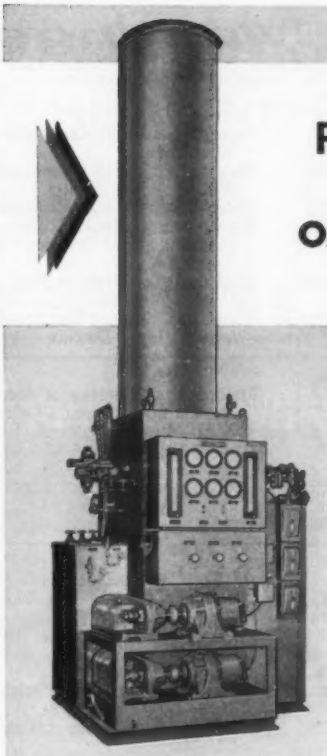
Giant 50,000-gallon collapsible tank for storage of military fuels has been developed by Army laboratories at Ft. Belvoir. Made of two-ply nylon cloth treated with synthetic rubber, it weighs 2,700 pounds empty.

Japanese government has approved, subject to approval of Diet, **increase from 2 to 7 percent in tariffs on imported crude** and from 6.5 to 10 percent on heavy fuel oil.

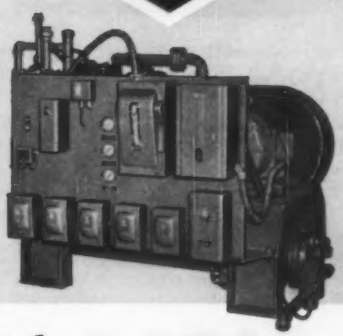
New headquarters of American Chemical Corp. were established December 9 in company's newly completed office building, 2112 East 223rd St., Long Beach, Calif.

Esso, A.G. plans to borrow $9.5 million to finance expansion in West Germany. Fifteen-year loan is mainly for refinery and pipeline expansion in North.

The Accepted Standard in
Package Type Plants
producing
OXYGEN and NITROGEN
Simultaneously



plus
a new package type Refrigeration Unit



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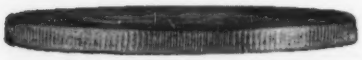

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Naval Stores Department
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Meetings Calendar

Jan. 1960	
18–20	**Compressed Gas Association,** Annual Meeting, Waldorf-Astoria Hotel, New York.
22	**Natural Gasoline Association of America,** Gulf Coast Regional Meeting, Robert Driscoll Hotel, Corpus Christi.
25–28	**Plant Maintenance & Engineering Show,** Convention Hall, Philadelphia.
27–28	**Western Petroleum Refiners Association,** Gulf Coast Regional Technical-Industrial Relations Meeting, White Plaza Hotel, Corpus Christi, Texas.
28–29	**National Association of Corrosion Engineers,** Course in Practical Corrosion Control Systems, Rice Hotel, Houston.
31-Feb5	**American Society for Testing Materials,** Committee D-2 Meeting, Statler Hotel, Detroit.
Feb.	
1– 5	**Instrument Society of America,** Instrument-Automation Conference and Exhibit, Houston Coliseum, Houston.
1– 5	**ASTM,** Committee Week, Hotel Sherman, Chicago.
21–24	**American Institute of Chemical Engineers,** Meeting. Hotel Biltmore, Atlanta.
23–26	**American Society of Mechanical Engineers,** Symposium on Thermal Properties of Gases, Liquids and Solids, Purdue University.
26	**NGAA,** Permian Basin Regional Meeting, Lincoln Hotel, Odessa, Texas.
March	
6– 9	**ASME,** Gas Turbine Conference and Exposition, Rice Hotel, Houston.
14–18	**NACE,** Annual Meeting, Memorial Auditorium, Dallas.
18	**NGAA,** Oklahoma Regional Meeting, Biltmore Hotel, Oklahoma City.
28–30	**WPRA,** Annual Meeting, Hilton Hotel, San Antonio.
April	
19–21	**Southwestern Gas Measurement Short Course,** Drill Hall, North Campus, University of Oklahoma.
20–22	**National Petroleum Association,** Semiannual Meeting, Hotel Cleveland, Cleveland.
20–22	**Texas A. & M. Symposium,** Instrumentation for the Process, College Station, Texas.
21–22	**ASME-SAM,** Management Conference, Statler Hilton Hotel, New York.
25–26	**ASME,** Maintenance and Plant Engineering Conference, Chase-Park Plaza, St. Louis.
25–29	**American Welding Society,** Annual Meeting and Welding Exposition, Los Angeles.
27–29	**NGAA,** Annual Convention, Rice Hotel, Houston.
May	
2– 6	**American Petroleum Institute,** Midyear Meeting, Safety and Fire Protection Committees, Atlanta-Biltmore Hotel, Atlanta.
9–12	**API,** Midyear Meeting, Division of Refining, Statler and Sheraton-Cadillac Hotels, Detroit.
9–13	**American Society for Metals,** Southwestern Metal Congress and Exposition, Sheraton and Other Hotels, Dallas.
22–26	**ASME,** Oil and Gas Power Conference and Exhibit, Muehlebach Hotel, Kansas City, Mo.
23–26	**Design Engineering Show,** New York Coliseum.
June	
5–10	**ASME,** Semi-Annual Meeting and Aviation Conference, Statler Hilton Hotel, Dallas.
5–10	**SAE,** Summer Meetings, Edgewater Beach Hotel, Chicago.
19–22	**AIChE,** Meeting, Del Prado Hotel, Mexico City.
26-Jul 1	**ASTM,** Annual Meeting and Apparatus Exhibit, Chalfonte-Haddon Hall, Atlantic City.
Aug.	
15–17	**ASME-AIChE,** Heat Transfer Conference and Exhibit, Statler Hilton Hotel, Buffalo, N.Y.
Sept.	
14–16	**National Petroleum Association,** Annual Meeting, Hotel Traymore, Atlantic City.
15–16	**ASME,** Engineering Management Conference, Hotel Morrison, Chicago.
18–21	**ASME,** Petroleum Mechanical Engineering Conference, Jung Hotel, New Orleans.
21–23	**ASME-AIEE,** Power Conference, Bellvue-Stratford Hotel, Philadelphia.
25–28	**AIChE** Meeting, Mayo Hotel, Tulsa.
25–28	**American Institute of Electrical Engineers,** Electrical Conference of the Petroleum Industry, Hotel Skirvin, Oklahoma City.
Oct.	
9–12	**ASME,** Rubber and Plastics Conference, Lawrence Hotel, Erie, Pa.
10–11	**ASME-AIEE,** Fuels Conference, Daniel Boone Hotel, Charleston, W. Va.
11–14	**NACE,** Northeast Region Conference, Prichard Hotel, Huntington, W. Va.
25–28	**NACE,** South Central Region Conference, Mayo Hotel, Tulsa.

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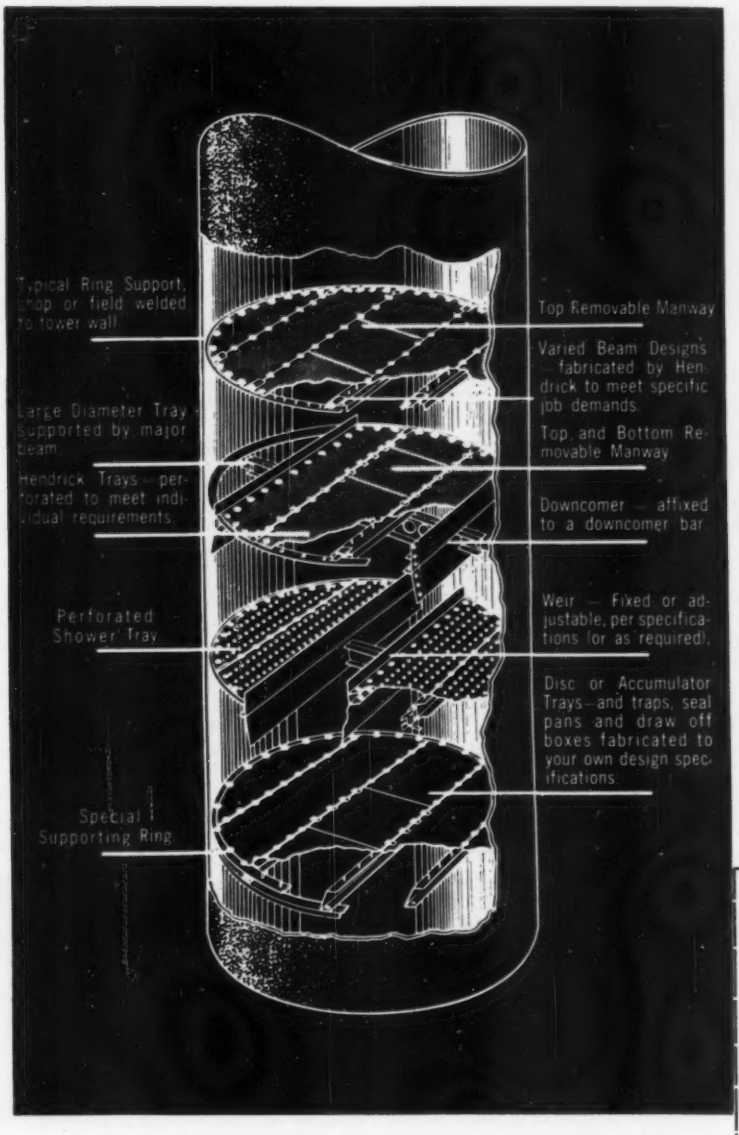
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Men In Industry...

Tracy

Scholl

O. V. Tracy has been elected to succeed **William Naden** as president of Esso Standard Oil Co. **Robert H. Scholl** succeeds **E. Duer Reeves** as executive vice president. Tracy has been a director of Esso Standard since 1954 and a vice president since 1956. His responsibilities have included all company refining and petrochemicals operations. From 1952 until last year, he was president of Enjay Co., Inc., and he is a former general manager of Esso's Chemical Products Department. Scholl has been an Esso vice president and director since 1954. He joined Esso in its Law Department in 1937, was named associate general counsel in 1946 and general counsel in 1949. He served as general counsel until his election as a vice president and director. Naden, who had been president of Esso since August 1958, is an executive vice president and director of the new Humble Oil & Refining Co. Reeves is a vice president and director of Humble. He had been executive vice president of Esso Standard for the last year.

Marvin W. Crowe has been named director of training for Continental Oil Co.'s Manufacturing Department, Houston. He was formerly fire marshal and safety supervisor at Conoco's Lake Charles refinery. Crowe joined Conoco at Lake Charles in 1954 and held key engineering positions at the refinery before his promotion in 1956 to fire marshal and safety supervisor. He has a B.S. degree in mechanical engineering from The University of Texas.

Alan H. Temple has been elected a member of the Monsanto Chemical Co. board. He is presently vice chairman of the board and a director of The First National City Bank of New York. Temple is a director of several insurance companies, the Mead Corp. and Moore Corp., Ltd. He is a trustee of Columbia University, the Committee for Economic Development and the National Industrial Conference Board.

L. D. Fergesen has joined the staff of the Whiting Research Laboratories of Standard Oil Co. (Indiana), where he will do research on plastics derived from petroleum products. Fergesen has a B.S. degree in chemistry from Cornell College and a M.S. degree in chemistry from Cornell University. He is a member of ACS.

H. A. Mayor, Jr., of Southwest Grease and Oil Co., has been named president of the National Lubricating Grease Institute. **F. R. Hart,** Standard Oil Co. of Calif., is vice president, **C. L. Johnson,** Jesco Lubricants Co., is secretary, and **A. J. Daniel,** Battenfeld Grease and Oil Co. is serving his eighth term as treasurer. Mayor has been a director of NLGI since 1953 and has chairmanned a number of important committees. Hart has served on the governing body since 1955, while Johnson has been on the board since 1953. Daniel is serving his eighth consecutive term as treasurer after having been president (1949) and a director since 1945.

Jones

Comeaux

Dr. J. A. Dinwiddie has been promoted to section head and **W. C. Jones** and **R. V. Comeaux** to research specialists in Humble Oil & Refining Co.'s Research and Development Division, Baytown, Texas. Dr. Dinwiddie heads a section engaged in analytical research and organic analysis, Jones specializes in the development and application of various separation techniques to quantitative analysis, and Comeaux deals in research on corrosion problems. Dinwiddie has a Ph.D. degree in chemical engineering and B.A. and M.A. degrees in chemistry. Jones has a B.A. degree in chemistry and Comeaux holds a B.S. degree in chemical engineering.

Dinwiddie

George B. Boon, a mechanical engineer with Monsanto Chemical Company's Research & Engineering Division, St. Louis, has been promoted to Technologist. Holder of a mechanical engineering degree from Rensselaer Polytechnic Institute, he joined Monsanto in 1946. Boon served in various engineering capacities with the General Engineering Department until 1953, when he became a member of the Atomic Electric Project Group, Clayton, Mo. He transferred to the Inorganic Chemicals Division in 1955 and to the Research & Engineering Division in 1957.

Dr. Richard F. Robey has been appointed a research associate in the Chemicals Research Division of Esso Research and Engineering Co. Previously head of a section responsible for all analytical work, he will devote his efforts to work on chemicals products research. Dr. Robey holds B.S., M.S. and Ph.D. degrees in chemistry from Ohio State University. He joined Esso Research in 1937 as a research chemist.

Ernest P. Zseleczky has been promoted to head of the Operations Section, Computing Center, Esso Research and Engineering Co., New York. He is a charter member of the Computing Center, established in 1957. Zseleczky has been with Esso Research more than six years. He joined the company soon after receiving a B.S. degree from Columbia University in industrial and management engineering. He has since earned a M.S. degree from Columbia University.

Gardiner Symonds, board chairman and president of Tennessee Gas Transmission Co., Houston, has been elected national chairman of 1960 Invest-in-America Week, to be observed throughout the nation April 24-30. In accepting the 1960 chairmanship, Symonds said his goal will be to enlist the cooperation of all segments of industry, labor, agriculture, commerce and finance in the observance of 1960 Invest-in-America Week.

Dr. Edward D. Amstutz, professor of organic chemistry at Lehigh University, has been named head of the Department of Chemistry there. Dr. Amstutz succeeds **Dr. Earl J. Serfass** who has accepted a position as a member of the board of directors and vice president in charge of research and development, Milton Roy Co., Philadelphia. A member of the Lehigh faculty since 1938, Dr. Amstutz is a graduate of the College of Wooster, Institute of Paper Chemistry, and Cornell University.

Lee Carter, a Stone & Webster Engineering Corp. chemical process engineer, has been named to head the new office opened in Calgary, Alberta, by Stone & Webster Canada, Ltd., an affiliate. The new office will be at 917 Lancaster Building, Calgary, Alta. Since joining S & W in 1951, Carter has worked on the design and process engineering of petroleum refineries and chemical plants in the United States, Great Britian and Italy. He had previously worked with Universal Oil Products Co., Riverside, Ill.; Virginia-Carolina Chemical

Carter

Valves for the Petroleum Industry

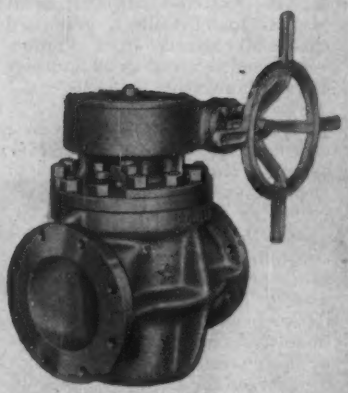

Fig. 3059G—300-Pound Steel Lubricated Plug Valve. Bolted gland type, gear operated. Sizes 6" to 12".

Fig. 2467—Small 300-Pound Stainless Steel O.S. & Y. Gate Valve.

Fig. 6061—600-Pound Steel Swing Check Valve.

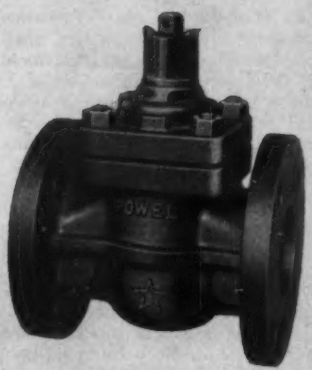

Fig. 2201—175-Pound W.O.G. Semi-Steel Lubricated Plug Valve. Single gland type.

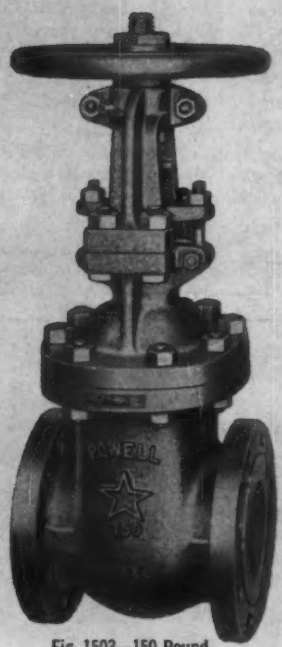

Fig. 1503—150-Pound Steel O.S.&Y. Gate Valve.

Fig. 375—Bronze Gate Valve for 200 pound W.S.P. Union bonnet, inside screw rising stem.

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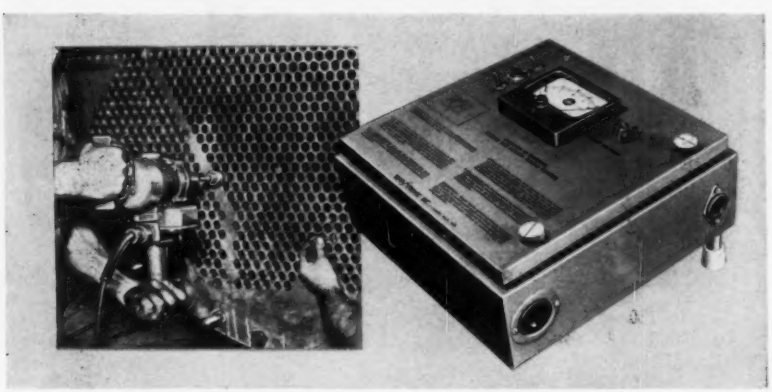

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Men . . .

Corp., Richmond, Va.; and E. B. Badger & Sons Co., Boston. Carter attended Morton Junior College, graduated as a chemical engineer from Purdue University and received an M.S. degree from Cornell University.

James D. Willson has been named controller of Tidewater Oil Co. He succeeds **Russell D. Richardson,** who continued to serve as controller after his appointment last year as finance vice president of Tidewater. Richardson will continue as finance vice president and as a member of the executive management of the company. Prior to joining Tidewater, Willson was finance vice president and a director of Norris-Thermador Corp., Los Angeles. Previous industrial experience includes five years as controller of the Plaskon Division of Libbey-Owens-Ford Glass Co.

Willson

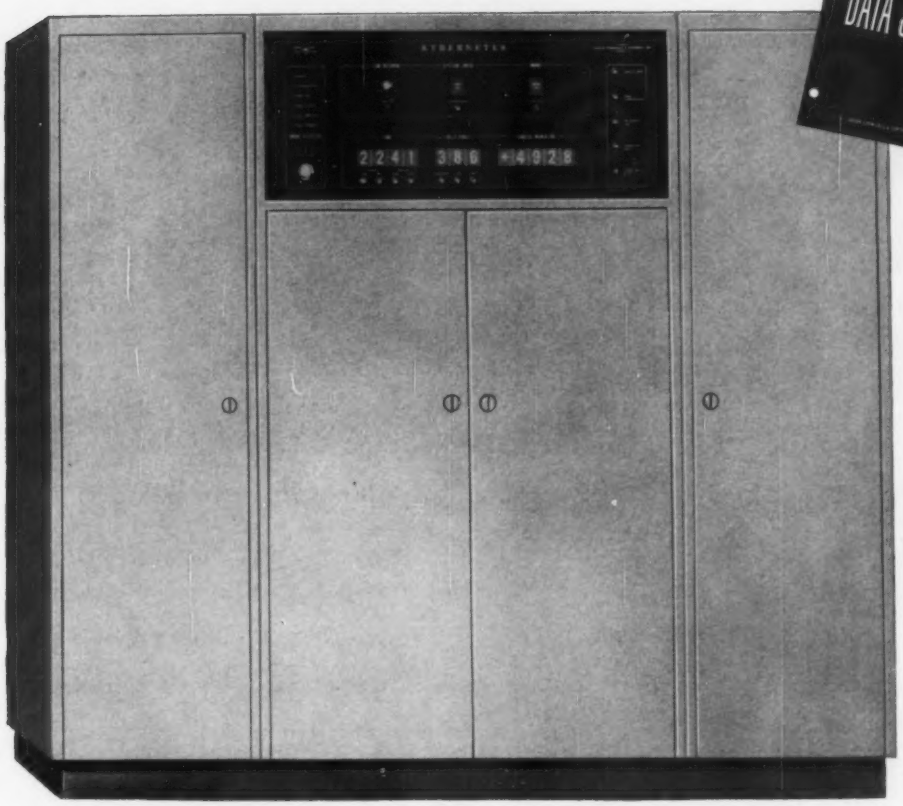
J. E. Woodward has been named superintendent of operations in Shell Oil Co.'s Houston area Gas Department. He was previously superintendent of Shell's Wasson gas plant in West Texas. Woodward received his B.S. degree in mechanical engineering from the University of Oklahoma, and began work with Shell as a junior mechanical engineer in New Orleans in 1948. In 1950 he was made gas engineer in Midland, and a year later became field gas engineer at the Wasson plant. Woodward went to New York as a gas mechanical engineer in 1953 and returned to the Midland area in 1956 as assistant superintendent of the TXL plant. He became superintendent at TXL later the same year and returned to Wasson as superintendent in 1958.

W. I. Leitzell and Rex W. Smyth have joined the Technical Development Section, Petrochemicals Department, Gulf Oil Corp. Both men will assist in the planning and development of new petrochemical activities. A graduate of Rensselaer Polytechnic Institute, Leitzell has 17 years experience in various phases of the chemical and plastics industries. Smyth has B.S. and M.S. degrees in chemical engineering from Carnegie Institute of Technology. He worked two years for Pennsalt Chemicals Corp. in the Plant Development Group, Natrona, Pa. plant. He joined Gulf Research & Development Co. in 1952. Prior to his most recent advancement, he worked there as a group leader doing pilot plant research in the Petrochemical Section, Process Division.

Douglas F. Mayfield has been named public relations manager at Esso Standard Oil Co.'s Baton Rouge refinery succeeding **W. B. Cotten, Jr.,** who headed the refinery's PR Department from 1943

For more data on advertised products, use Readers' Service Cards, last page.

For complete information on the many features of the Hagan Kybernetes Series 2000 data processing unit—phone or write for Bulletin MSP-161



Hagan Kybernetes® Data Processing Unit Offers...

ACCURACY • LOW MAINTENANCE • MANY EXTRAS

Hagan Kybernetes Series 2000 data processing is an all-electronic system for logging, computing and alarm scanning. Designed around modular chassis, with similar types interchangeable, the system includes linearization, square root extraction, AC to DC conversion, multiplication, division and digital alarm comparison.

Here are some of the unique features of the Series 2000:

CONTINUOUS ALARM SCANNING—Alarm scanning does not stop during logging, trend logging or visual display of any variables.

HIGH SPEED A to D CONVERSION—This feature allows parallel functions such as computing and integration to proceed without interfering with alarm scanning and logging.

HIGH RELIABILITY—Modular construction of plug-in chassis provides reduced down time and no inventory problems.

HIGH ACCURACY—Simplified design and highest quality components provide an overall accuracy of ±0.1% of full scale.

PINBOARD PROGRAMMING—Pre-wired pin board makes selection of operational characteristics, or changing them, extremely simple.

HAGAN

CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA

HAGAN DIVISIONS: CALGON COMPANY—HALL LABORATORIES—BRUNER CORP.

For more data on advertised products, use Readers' Service Cards, last page.

hē′li-ŭm

When you consider Helium-Recovery you will automatically think of Stearns-Roger.

Most of the operating helium plants in the free world have been built by Stearns-Roger. In this one organization is collected the cryogenic knowledge, experience and practical background to engineer and construct economical and satisfactory helium plants.

Stearns-Roger can provide you with reliable designs, investment studies and overall assistance in helium, hydrogen, natural gas and rare gas problems.

Direct inquiries to

Stearns-Roger

THE STEARNS-ROGER MFG. CO. • DENVER, COLORADO

- DENVER
- HOUSTON
- EL PASO
- SALT LAKE CITY
- CALGARY

P.O. BOX 5370 • DENVER 17, COLORADO

Men . . .

until his death last August. **J. Perry Brandao** succeeds Mayfield as assistant public relations manager and continues as editor of the refinery's employe newspaper. An engineer, with degrees from The University of Texas and Georgia Tech, Mayfield joined Esso at Baton Rouge in 1942. He was named assistant PR manager about two years ago. He is vice president of the Baton Rouge Section, Louisiana Petroleum Council. Brandao has a journalism degree from Louisiana State University. He joined Esso at Baton Rouge in 1948 and later received a M.S. degree in industrial communications from L.S.U.

Emil Pfister recently joined Universal Oil Products Co., as a consultant. He began his career in petroleum refining in 1920 at the Royal Dutch Shell laboratories in Amsterdam. Since 1929 he has been manager of the Royal Dutch Shell group of refineries in various parts of the world. Following the war, until his recent retirement, he was with Asiatic Petroleum Corp., New York, in charge of all technological matters connected with the refining and petrochemical industries. Pfister received his early technical training from the Federal Polytechnic University, Zurich, Switzerland, where he was awarded a chemical engineering degree.

Pfister

William Priestley, Jr., has been named director of Esso Research & Engineering Co.'s new Analytical Research Division, and **Hollis L. Leland** has been named assistant director. Priestley, until his new appointment, was an acting assistant director in the firm's Process Research Division. A chemical engineer, he attended the University of North Carolina for two years, then transferred to Lehigh University where he earned B.S. and M.S. degrees. He joined Esso Research in 1939. Dr. Leland moves to the new division from the Products Research Division where he headed the Analytical Section. A physical chemist, he received a Ph.D. degree from Ohio State University. His B.S. degree in chemical engineering was eraned at the University of Maine and his M.S. degree in physical chemistry from the University of New Hampshire. Dr. Leland joined Esso Research in 1937.

Dr. W. R. Marshall, Jr., professor of chemical engineering and associate dean of the University of Wisconsin, received AIChE's Professional Progress Award at the organization's recent San Francisco meeting. Other award winners were: **Dr. Bruce H. Sage,** professor of chemical engineering at California Institute of Technology—the William H. Walker Award for excellence of contributions to chemical engineering literature; **Dr. Sheldon**

American 200 Series Chemical Feed Pumps

• METERING ACCURACY OF ±1%

• CAPACITY TO 1624 GPH.

New 200 Series Simplex model can pump up to 812 gph. Duplex model has double this capacity. Maximum pressure of 10,000 psi.

Easy, inexpensive operation is assured by these quality features:

- Self-contained lubrication system—no downtime for lubrication.
- E-Z Clean Cartridge Valves simplify maintenance.
- Interchangeable liquid ends for greatest adaptability in the field.
- Precision screw adjustment on crank for easy accurate stroke regulation.
- Sealed Self-aligning bearings on crank and crosshead withstand greater radial and axial thrust loads.
- Crossheads of hardened and ground steel ride on cast iron.
- Heavy duty reducers.
- NEMA frame motors.

Precision built 200 Series pumps handle a wide variety of "tough," corrosive materials. In Chemical Processing, Refining and Boiler Feed operations, the pumps assure highest accuracy in feeding precisely metered fluids in virtually all ratios, with flow, temperature, pressure, conductivity, PH and other controlled process variables.

Write today for more information.

AMERICAN® METER COMPANY
INCORPORATED ESTABLISHED 1820
pump division
13500 PHILMONT AVE. PHILADELPHIA 16, PA.

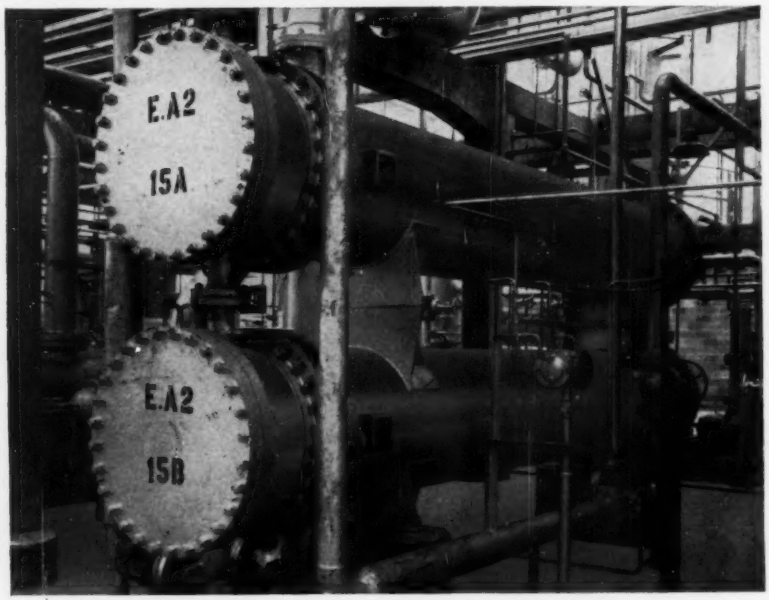
For more data on advertised products, use Readers' Service Cards, last page.

Men . . .

K. Friedlander, associate professor of chemical engineering at the Johns Hopkins University—the Allan P. Colburn Award (formerly called the Junior Award), for outstanding contributions to publications of the Institute by a younger member of the Institute; **J. R. Griffin,** DuQuoin, Ill., the A. McLaren White Award for placing first in the Institute's Student Problem Contest; **Francis J. Curtis,** retired vice president of Monsanto Chemical Co., and **Professor William H. McAdams,** professor of chemical engineering, Massachusetts Institute of Technology—the 1959 Founder's Award for important impact of their work on chemical engineering.

Macauley Whiting, general manager of The Dow Chemical Co.'s Midland Division, has been elected a member of the Dow board of directors. He was appointed division general manager in November succeeding the late **Dr. William H. Schuette.** With Dow since 1948, Whiting served as manager of Service Departments, Midland Division, for three years.

W. C. Franklin has been appointed manager of the new Polychemicals Department, Texas-Butadiene & Chemical Corp. The new division will be responsible for application research, market development, and sales of a new series of polymers, copolymers, and other polychemicals. Prior to his new appointment, Franklin was assistant sales manager.



EFCO Engineering Efficiency Gives JEFFERSON Most Economical Selection

Jefferson Chemical Company, Inc., is one among many process equipment users who profit from the economy provided by EFCO engineering efficiency. Years of experience in engineering and fabricating heat exchangers for the wide temperature/pressure ranges characteristic of ethylene and other manufacturing processes enable EFCO to offer service-proved engineering design and guaranteed job-ratings. Recognized specialists in handling all grades of carbon, alloy and stainless steels, and nickel, aluminum, and special low-temperature materials, EFCO provides technical service before, during and after installation.

EFCO'S FOUR POINT PROGRAM PROVIDES:

- service-proved engineering design
- guaranteed job-ratings
- complete fabricating facilities
- technical service before, during and after installation

TEMA

EFCO

ASK OUR GULF COAST CUSTOMERS—THEY KNOW US WELL

Write for General Catalog

ENGINEERS AND FABRICATORS, INC.

P. O. BOX 7395 • HOUSTON 8, TEXAS

Dr. Jerry McAfee has been named 1960 president of AIChE. His election followed a nationwide mail ballot by the more than 18,000 engineers in AIChE. Dr. McAfee is vice president, Manufacturing Department, Gulf Oil Corp., Pittsburgh. He earned his B.S. degree in chemical engineering from The University of Texas in 1937, and three years later was awarded his D.Sc. degree in chemical engineering from Massachusetts Institute of Technology. Dr. McAfee joined Gulf in May, 1945, at the company's Port Arthur refinery. He was transferred to the Harmarville Laboratories in 1950 and appointed director, Chemistry Division, Gulf Research & Development Co. In 1951, he became assistant director of research, assuming responsibility for all product and process work at the Laboratory. He served in this capacity until his election as vice president and associate director of research, Gulf Research & Development Co., in 1954.

McAfee

Larry Resen has been named chief editor of *Chemical Engineering Progress.* Formerly refining editor of the *Oil and Gas Journal* in New York, Resen succeeds **John B. Mellecker.** He has a B.S. degree in chemical engineering from the University of Colorado. Gulf Coast district editor for the *Oil and Gas Journal* at Houston for seven years, Resen had previously been with Dow Corning Corp., Midland, Mich. working in the Product Development Laboratories.

Dr. George W. Fiero of Esso Standard Oil Co. has been named president of the Chemical Specialties Manufacturers Association. He has been first vice president of the association for the last year. Since 1945 he has served at various times as chairman of several committees of the association, chairman of its Insecticide Division and a member of the board of governors. He was second vice president in 1958.

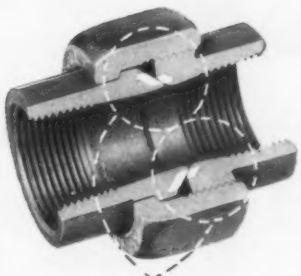
A. J. Head has been promoted to manager of Phillips Chemical Co. He has been manager of the manufacturing divisions of the company. Head graduated from the University of Oklahoma with a B.S. degree in mechanical engineering. He joined Phillips in 1937 and in 1951 became superintendent of the chemical company's Philblack plant, Borger, Texas. Four years later he transferred to Bartlesville and in 1957 was appointed to the position he held prior to his recent advancement.

Allen Myra has been appointed general manager of Standard-Vacuum Oil Co.'s producing and refining affiliate in Indonesia, succeeding **Bruno O. Winkler** who is returning for re-assignment. Myra joined the Halifax refinery of Imperial Oil, Ltd., in 1934, and became head of

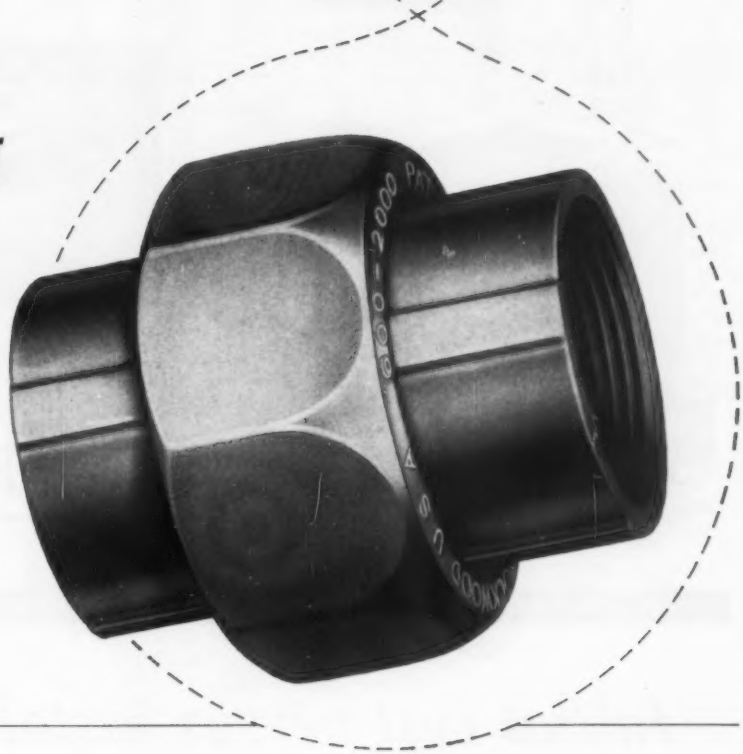
For more data on advertised products, use Readers' Service Cards, last page.

In Rockwood Unions . . .

the big hardness differential in seats



makes a big difference in the entire union



In Rockwood Union #603 both seats are made of corrosion-resistant AISI molychrome steel, forged in place and double-locked under 100,000-pound and 400,000-pound pressures.

The male seat is specially heat treated to make it 150 Brinell harder than the female seat.

No other union has this hardness differential, which eliminates galling in make-up and assures long, trouble-free service life.

There are other big differences in Rockwood Unions that mean greater safety and economy. For example:

- an exclusive cold forging process results in easily interchangeable parts, all with highest resistance to shock, jar, vibration, expansion and contraction.
- balanced design distributes built-in strength uniformly throughout each Union.
- "Rockwoodizing," a special coating process, protects threads and all other surfaces against corrosion.
- Color-coding of different type Rockwood Unions enables easy identification by warehousemen and pipe fitters.

Rockwood Unions are tested and listed by Underwriters' Laboratories, Inc., for use with flammable liquids and gases. Write for complete facts.

ROCKWOOD SPRINKLER COMPANY
A Division of The Gamewell Company
Distributors in all principal industrial areas

ROCKWOOD SPRINKLER COMPANY
A Division of the Gamewell Company
727 Harlow Street
Worcester 5, Massachusetts

Please send me prices and further information on Rockwood Unions.

Name _____

Title _____

Company _____

City _____ *Zone* ____

State _____

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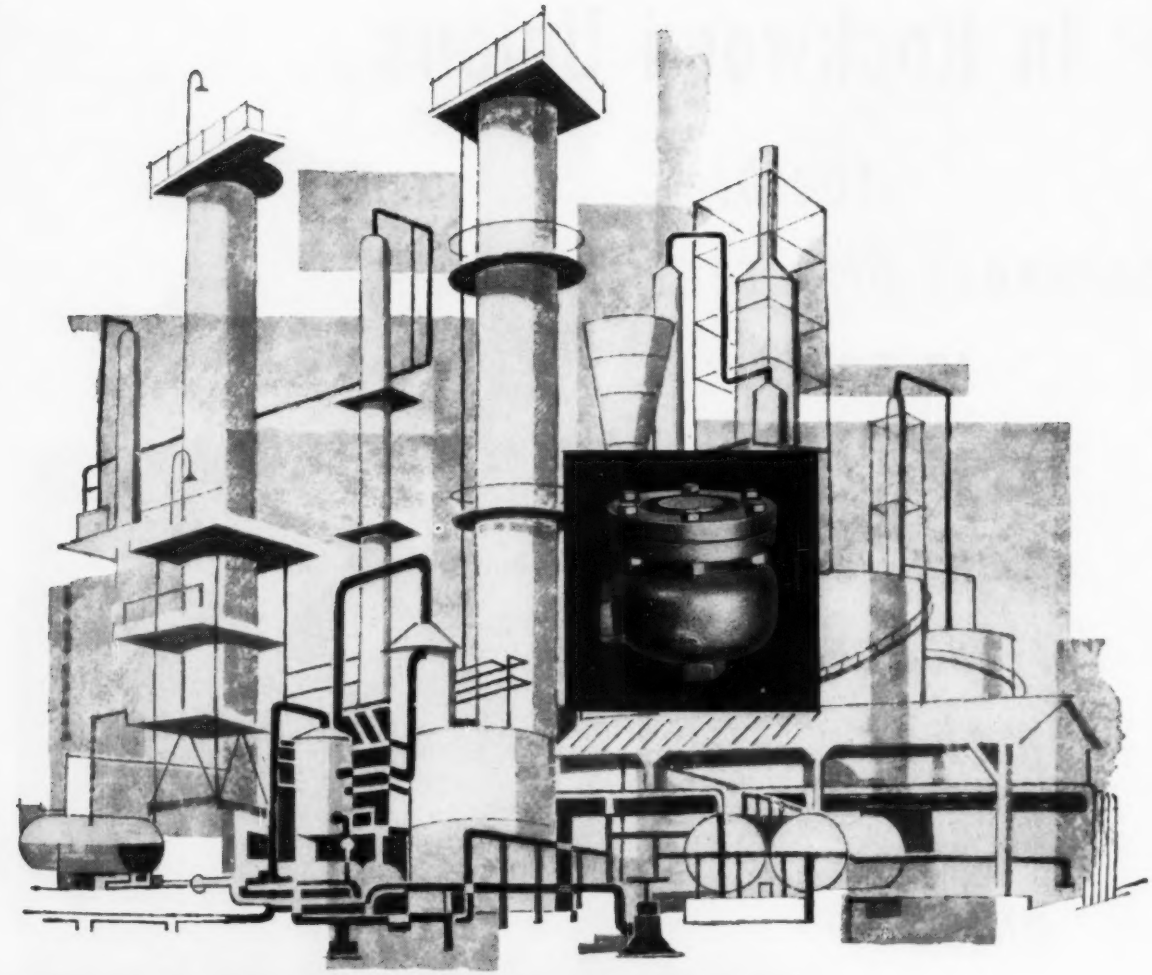


THE ECONOMICS OF STEAM TRAP SELECTION

Initial cost versus installed cost

Everybody wants to save money in the purchase of steam traps, or anything else.

But a wise buyer will recognize that the *real cost* relates to the entire useful life of his plant, and that selection of the most efficient trap for a given application is an important consideration.

Compare the efficiency of Nicholson traps with that of so-called "bargains" and you'll see why plant engineers responsible for successful operation usually insist on Nicholson.

ST-102

NICHOLSON

OF WILKES-BARRE

W. H. Nicholson and Co. • 14 Oregon Street • Wilkes-Barre, Pa.

Distributors in all principal cities

Men . . .

its Technical Department in 1941. Transferred to the company's Toronto headquarters in 1946 he was named process superintendent of Imperial Oil's new Edmonton refinery two years later. He left Canada in 1952 to become general superintendent of Stanvac's Bombay, India, refinery. Three years later he became managing director of Standard-Vacuum Refining Co. of India, Ltd. He moved to Palembang, Sumatra, in 1957 where he has been assistant general manager of Stanvac's operating organization in Indonesia.

A. L. Burns, a director of Gulf Publishing Co. and a pioneer in the company's development, was killed December 31 when a plane he was piloting crashed in a rainstorm at Eagle Lake, Texas. Burns, 66, was a native Texan who had been with Gulf Publishing since 1920. He had served as vice president and general manager for many years before he resigned in January 1956 to head Gulf Printing Co. (It and Gulf Publishing are affiliated companies although separate corporations.) Funeral services were held January 2 with burial in Houston.

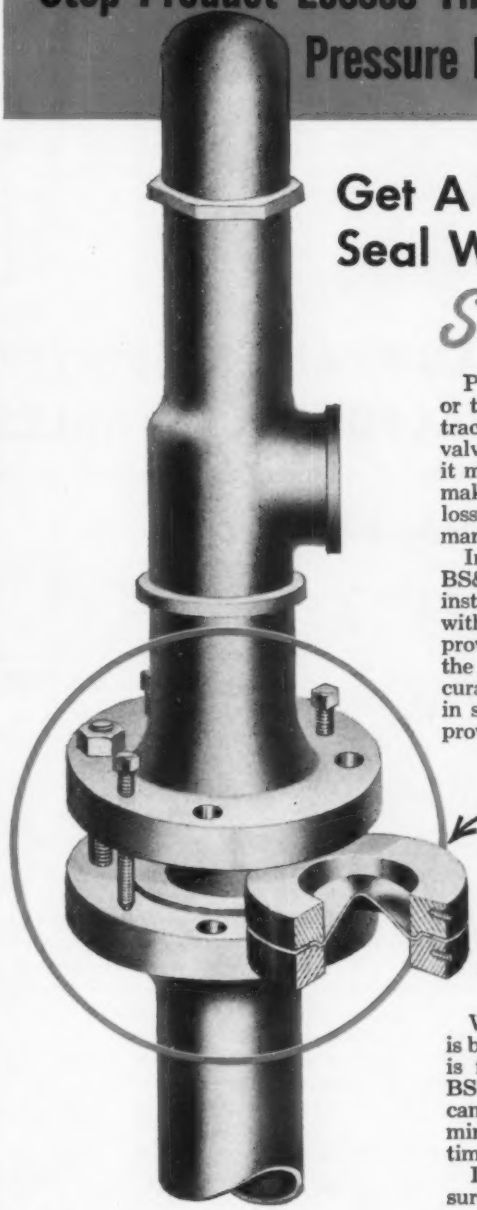
George E. Best has joined the staff of the Manufacturing Chemists' Association as staff secretary to committees on air and water pollution abatement and chemical packaging. He will also handle special assignments. Best, who comes to MCA from Allied Chemical Corp., has had 20 years' experience in the chemical industry, and is a graduate of the Massachusetts Institute of Technology. A member of MCA's Air Pollution Abatement Committee from 1949-55, he is president elect of NACE.

George W. O'Dair has been elected treasurer and **Leon W. Linebarger** comptroller of Commonwealth Oil Refining Co., Inc. Both men are located in the company's executive office, Ponce, Puerto Rico. O'Dair joined Commonwealth in 1954 and had been comptroller since January 1958. Linebarger, who was previously with affiliates of Standard Oil Co. (New Jersey), Shell Oil Co., and S. D. Leidesdorf & Co., joined Commonwealth in December 1958.

Louis Oleari has been named assistant manager of California Chemical International, Inc., Latin America-Asia Division. The territory includes Japan, Hong Kong, Australia, Thailand, India and other Far East markets as well as Mexico, Central and South America and the Caribbean countries. Previously Oronite Chemical Co.'s district sales manager for the Southern United States, Houston, his new office will be at the company's headquarters, San Francisco.

William J. Harvey, vice president in charge of gas operations, Public Service Electric and Gas Co., Newark, N.J., has been appointed chairman of the American Gas Association's Laboratories Managing Committee. Elected an A.G.A. director in 1958, he is a mechanical en-

Stop Product Losses Through Leaking Pressure Relief Devices!



Get A "Bottle-Tight" Seal With BS&B *Safety Heads!*

Product loss in a processing or transfer system can often be traced to leaking pressure relief valves. To make matters worse, it may be extremely difficult to make repairs that will stop this loss with any degree of permanence.

In hundreds of such cases BS&B Quik-Sert Safety Heads, installed upstream and in series with the leaky relief device, have provided the perfect solution to the problem. Pressure relief accuracy is in no way impaired . . . in some cases it is actually improved.

When pressure in the system is bled back to normal, the valve is free to close as usual. The BS&B Quik-Sert Safety Head can be replaced in a matter of minutes at any later convenient time.

If you need a leak-tight pressure relief assembly for normal operation of your pressured systems, BS&B Safety Head specialists will gladly survey your installation and submit recommendations.

Write now for details.

BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept. 2-F1
7500 East 12th Street
Kansas City 26, Missouri
Telephone: BEnton 1-7200

OVER 60 YEARS
BS&B
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

For more data on advertised products, use Readers' Service Cards, last page.

Men . . .

gineering graduate of Columbia University. He has served with Public Service and its predecessor companies since 1916. Before being named to his present post in 1955, he was superintendent of gas distribution, superintendent of gas production, engineer of construction, general superintendent of production and general manager.

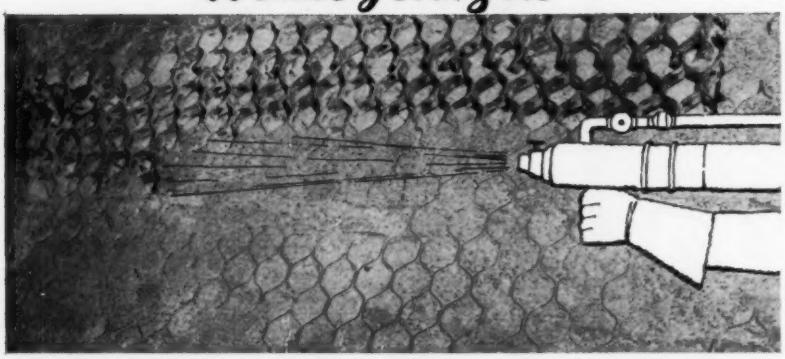
Alfredo Larachaga has been named New York representative for Petroleos Mexicanos, with offices at 74 Trinity Place, Suite 1900, New York 6.

Dr. Francis P. Baldwin has been named a research associate in the Chemicals Research Division, Esso Research and Engineering Co. He will head a project team engaged in exploratory elastomer research. He had been head of a section responsible for coordinating product development work on plastic materials. Baldwin started his Esso Research career in 1937 as a messenger. He later became a laboratory assistant and earned a B.S. degree in chemistry by going to night-school at Wagner College. He has a Ph.D. degree in physical chemistry from Notre Dame University, where he also had a teaching fellowship in the physics department.

MAJOR OIL COMPANIES SPECIFY WALSH REFRACTORY CASTABLES

An Investment in Greater Production . . . Lower Cost . . . because they're

"Homogenized"



Perfect balancing and blending—a marked uniformity of grain structure for absolute homogeneity is just one of the extras in Walsh Refractory Castables for the refining industry. Together with superior bonding qualities, maximum resistance to abrasion, excellent compaction, low rebound loss and high modulus of rupture, you get all the wanted characteristics that result in more efficient service throughout a longer life. There is a light weight insulating, high temperature service type, or iron and sulphur-free castable with suitable "K" factor to meet every refinery need—whether for airgunning, pouring, or trowelling—that will do your job better at less cost.

WEAR-RESISTANT TYPES

H & B CASTABLE
ALSO AVAILABLE—Super Castable No. 32 (iron-free)
HI-AL CASTABLES—(Tabular Alumina)

LIGHT WEIGHT INSULATING TYPES

LITE-WATE No. 70, for one-shot lining, 70 lbs./cu. ft.
LITE-WATE No. 50, for back up, 50 lbs./cu. ft.
LITE-WATE No. 50 NISF (Iron and Sulphur-free)

Complete technical data, directions for airgun application, mixing, pouring, curing, drying, etc. are contained in fully illustrated brochure. Write for your free copy today.

WALSH REFRACTORIES CORPORATION
101 Ferry Street • St. Louis 7, Missouri
For over 60 years manufacturers of high grade refractories

Marvin F. Miller has been appointed manager of labor relations for Standard Oil Co. of Calif. He was formerly assistant general manager of the company's Richmond refinery. Miller joined Standard in 1926 and served 11 years in the Research and Development Department. In 1937 he transferred to the manufacturing field and filled a variety of positions at company plants in California, the Middle East and New Jersey. He was named manager of operations at Richmond in 1953 and assistant general manager two years later. Miller is a 1926 graduate of the University of California.

Frank Gonet has been named chief of the chemical division, U.S. Tariff Commission, Washington, D.C. He is the commission's consultant on coal-tar intermediates and dyes. **Thomas J. Scott** has been appointed assistant chief. He is the commission's consultant on petroleum. The Chemical Division prepares the annual report, Imports of Coal-Tar Products, and the preliminary and annual reports, Synthetic Organic Chemicals, and U.S. Production and Sales.

Alex A. Diffey has been named assistant general manager of marketing, Esso Standard Oil Co. For the last two years he has been operations manager in the Marketing Department at Esso's New York headquarters. Earlier he was manager of the company's North Carolina Sales Division and assistant manager of its New England Division.

— Deaths —

Dr. John V. Starr, 57, manager of the Products Planning Division of Esso Standard Oil Co.'s Petroleum Specialties Department, died December 6 at his home in Cranford, N. J. With Esso since 1928, Dr. Starr was manager of the company's Manufacturing Technical Service Division, Linden, N. J., during most of the 1940's. For five years he was technical assistant to the general manager of East Coast manufacturing. He moved to Esso's Manufacturing Department, New York, in 1951 as assistant manager of the Lubricants and Specialties Division.

Quinton S. Peters, 40, assistant manager of public relations for Sunray Mid-Continent Oil Co., died December 2 in Tulsa. He joined Sunray in 1955, formerly having been a reporter for the *Tulsa World*. He was also with another oil company and a Tulsa public relations firm. Peters graduated from Oklahoma University in 1948 and served in the Merchant Marines during World War II. He is survived by his widow and three daughters.

T. Orchard Lisle, 73, publisher emeritus of *International Oilman* magazine, died December 1. Born and reared in England, he came to the United States at age 28 and embarked on a career in journalism, having served on several publications including oil-trade journals.

For more data on advertised products, use Readers' Service Cards, last page.

OCTANE RATING IS DETERMINED by running fuel samples in a single-cylinder test engine, like the one that's shown in operation.

ACCURATE QUALITY CONTROL IS EASIER WHEN STILLS ARE EQUIPPED WITH AN **AIR PREHEATER**

Average product ratings are up as much as two octane numbers at one East Coast refinery, because their Air Preheater permits maximum utility and completely accurate control of advance design units. At this refinery, the ability to control product quality accurately resulted in an extra annual income of $58,000.

You can get continuous peak performance from the most modern heat transfer system with a Ljungstrom® gas-to-gas regenerator. A Ljungstrom can recover as much as 1000° F heat from the exhaust of stills or boilers. Instead of letting this heat escape up the stack, the Ljungstrom returns it to the furnace combustion air.

Hotter combustion air can boost the output of a pipe still, too — by as much as 25%. Or, it can cut your fuel bill by an equal amount. Some plants have "written off" the cost of their Ljungstrom in 9 months.

Here's documented evidence. One company's fuel savings with a Ljungstrom Air Preheater are factually described in a published magazine article by O. F. Campbell. A reprint of this case history is yours free. Simply write to Air Preheater Corp.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

Suppliers Notes...

A three-day seminar was conducted recently by Crane Packing Co. for Southwest area customers, at The Houston Engineering and Scientific Society headquarters, Houston. Attendance included 30 engineering, operating and maintenance supervisors from petroleum refining and petrochemical plants in the area. Theme of the seminar, "How To Get The Most From Your Seal And Packing Dollar," aimed at developing a practical procedure for the selection, installation and maintenance of mechanical seals and packings, with particular emphasis on proper usage to save money and increase production efficiency. The meeting consisted of talks by Crane Packing Co. engineers, group discussion and demonstrations. Participants made a number of contributions toward the solution of difficult problems encountered by industries using seals and packings.

Tretolite Co. has moved into its newly completed Great Bend, Kan., area headquarter facilities. Offices, a stock warehouse, and a modernly equipped technical laboratory comprise the new structure. Donald Garland, former laboratory technician at the company's main plant and research laboratory in St. Louis, Mo., will be in charge of the facility.

BECKMAN INSTRUMENTS, INC., has named **Mrs. Jane Bishop** supervisor of advertising services. She will be responsible for providing art, production and traffic services for the company's Corporate and Division Advertising departments. She assumes the new post after serving as advertising production assistant for Beckman's Helipot Division. Prior to joining Beckman in 1957, Mrs. Bishop was with Foote, Cone and Belding, Inc., Los Angeles and Hollywood.

LINK-BELT SPEEDER CORP. has named **C. M. Basile** president. With Link-Belt since 1928, he was previously in plants at Chicago and Philadelphia in various phases of manufa turing. Since coming to Link-Belt Speeder in 1950, he has been a director and vice president in charge of operation. Recently, he was elected executive vice president of the Cedar Rapids plant and president of Link-Belt Speeder (Canada), Woodstock, Ont.

ETHYL CORP. has increased its commercial capacity for making aluminum alkyls and alkyl aluminum halides, with a new plant recently completed at Orangeburg, S. C. The unit is said to be the first major plant completed in the United States for production of aluminum alkyls. In operation since October, the plant utilizes several methods for producing these alkyl aluminum compounds, including a triethyl aluminum process developed by Ethyl.

ACF INDUSTRIES, INC. has appointed **Raymond P. Charnaux** director of foreign operations. He came to ACF from Yale and Towne's international operations. Before that he managed international operations for Robertshaw-Fulton Controls Co. In 1957 he was named vice president of Robertshaw-Fulton International. Charnaux also has served Canadian Westinghouse International, Ltd., and French General Electric Co. in export sales and international operations.

DAGWELL-DIXIE CO., 816 West Main St., Oklahoma City, has been named a distributor for industrial hose and reusable fittings made by Parker-Hannifin Corp. Technical assistance, as needed, will be provided by **K. R. Detrich,** Parker-Hannifin manager of distributor sales in the district including Oklahoma.

LOUISVILLE FIRE BRICK WORKS, Louisville Ky., has elected **Norman C. Updegraff** executive vice president. He has been in engineering and sales work for Girdler Construction Corp. and its predecessor companies since 1946. Prior to that time he was a production supervisor at E. I. duPont de Nemours & Co.'s Louisville Works.

THOMAS A. EDISON INDUSTRIES' Instrument Division has named Stepco Co., El Paso, Texas, to sell its temperature monitoring equipment. Acsi Engineering Co. will represent Edison in Northern Texas, and Electronic Components Sales, Inc., Denver, will represent the company in Colorado.

BASSICK CO. has named **Francis E. Hummel** manager of distributor sales and marketing. He will continue to be responsible for the company's promotional programs. Formerly assistant professor of marketing, Amos Tuck School of Business Administration, he joined the Bassick sales staff in 1955.

CONSOLIDATED SYSTEMS CORP. has appointed **Robert L. Feagins** manager of its Southern Region, comprising 14 Southern and Southwestern states with headquarters in Atlanta. Feagins joined CSC in July 1959 as an engineering representative, Western Region.

WOLVERINE TUBE DIVISION of Calumet & Hecla, Inc., has opened two new district sales offices in Los Angeles and San Francisco. Wolverine has been represented by Van D. Clothier, Inc., as West Coast agent, and this company will continue to serve in a sales counselling capacity.

THE OAKITE CO. has named **Edward C. Brass** manager of the Cleveland office succeeding **Fred J. Dahleiden,** who has retired. **Walter G. Huber** has been appointed manager of the Detroit office, succeeding **Milton A. Bergdahl,** who has also retired.

OLIN MATHIESON CHEMICAL CORP.'s Packaging Division has started up a new corrugated container sheet plant in Dallas. It contains approximately 45,000 square feet of floor space and has a production capacity of 5 million square feet of corrugated containers per month. **Stewart M. Norris** will manage the plant.

HOOKER CHEMICAL CORP. has named **A. Richard Perry** assistant corporate controller. **George C. Richards** succeeds Perry as controller of the company's

AIRETOOL
PNEUMATIC TOOLS...
the petroleum industry's top choice for tube maintenance

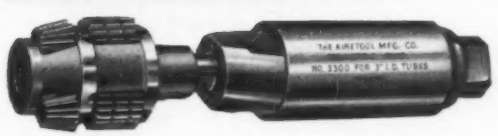
Leaders in the giant petroleum industry know the importance of an effective maintenance program — to control costs and keep equipment on stream. That's why they specify Airetool to assure a program of fast, efficient tube maintenance.

And there's good reason for this confidence in Airetool. It's based on a 30-year relationship during which Airetool engineers have worked side by side with petroleum engineers in licking tough tubular maintenance problems. Many of Airetool's pioneering innovations have produced tools that help the oil industry take full advantage of technological advances—with important savings in maintenance costs.

Every piece of Airetool equipment is the result of research and development evolving from the combined operating and engineering experience of manufacturer and user. Airetool dependability and performance — your assurance of low cost, effective tube maintenance — are founded on research, design, quality materials and precision manufacturing methods. And, all of Airetool's experience is available to you — no matter what the scope of your operations. Get the full details from your Airetool representative. Descriptive literature is available on request.

(Right) Airetool's new lightweight CC-475 Cleaner is ideal for one man operation and speeds cleaning of condenser and heat exchanger tubes up to 1 inch in diameter. Built-in flushing system keeps cleaning heads cool and tubes free of debris. In addition to the CC-475, Airetool produces a complete range of condenser and tube cleaners for every type and size tube.

(Below) Airetrol Automatic Tube Expansion Control rolls tight, uniform tube joints up to 720 tubes an hour. Quick-set torque-sensing mechanism stops expansion automatically to .001" accuracy.



(Above) Airetool Tube Cleaners are available in a complete range of sizes for every type of tube.

(Below) Airetool Internal Tube Cutter for cutting ⅝" to 1" steel and non-ferrous tubes in tube sheets up to 4 inches thick. Positive feed control speeds tube removal.

For complete Airetool line see our 28-page section in The Refinery Catalog.

AIRETOOL
MANUFACTURING COMPANY
316 S. Center St.
SPRINGFIELD, OHIO

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.
REPRESENTATIVES in principal Cities of U.S.A., Canada, Mexico, South America, England, Puerto Rico, Italy, Japan, Hawaii.
EUROPEAN PLANT: Vlaardingen, The Netherlands.
CANADIAN PLANT: Brantford, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

A UNIQUE CHECK VALVE THAT'S UNSURPASSED IN WATER, AIR, OIL OR GAS SERVICE

SILENT • SEATLESS • LOW PRESSURE DROP

Technocheck©

OUTPERFORMS • OUTWEARS OTHER VALVES • COSTS LESS TO MAINTAIN

In field service in a wide range of water, gas, air and oil applications, Technocheck's performance and reliability are unsurpassed. Its exclusive design eliminates valve seats. Tight sealing, low pressure drop and long life with low upkeep are some of its important characteristics.

SCHEDULE OF STANDARD VALVE SIZES

GENERAL DESCRIPTION	PSI	SIZES
Cast Iron, Flanged	125	4", 6", 8"
Steel, Male Threaded Ends	150	1½", 2", 2½", 3"
Steel, Flanged	150	3" 4", 6", 8"
PVC, Male Threaded Ends	125	1½", 2", 3"
PVC, Flanged	125	2", 3"
PVC, Flanged	50	4", 6", 8"

We invite inquiries on other sizes and in special materials.

Techno Corporation Dept. PR
16 West 5th Street, Erie, Pa.

CONTROL ENGINEERS
CHEMICAL ENGINEERS

RW-300 COMPUTER SYSTEMS FOR PROCESS CONTROL

The Thompson-Ramo-Wooldridge Products Company is seeking chemical, electrical, or mechanical engineers with training or experience in process or control system analysis, analog or digital computers, and instrumentation. Staff members at TRW Products work in small teams designing and evaluating RW-300 computer control systems for the process industries. Experience in the petroleum refining, chemical, steel, or electric power industries is particularly desirable. Applicants with advanced degrees are preferred. Those interested are invited to call BRadshaw 2-8892 or write:

Dr. Thomas M. Stout, Process Analysis Department Manager

THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY

a division of Thompson Ramo Wooldridge Inc.

202 North Canon Drive • Beverly Hills, California

Suppliers . . .

Eastern Chemical Division. A graduate of the University of Illinois, Perry joined Hooker at Niagara Falls in May 1956, and has been controller of the Eastern Chemical Division since it became autonomous early in 1959. Richards, with the company's Canadian subsidiary, Hooker Chemicals, Ltd., North Vancouver, B.C., since 1955, has been assistant treasurer for the past three years.

HOOKER CHEMICAL CORP.'s Eastern Chemical Division Sales Department has named **Joseph E. Thornberg** manager of market research. He is a Northeastern University graduate with a B.S. degree in chemical engineering. With Hooker since 1943, Thornberg has been in the Sales Department for the past six years. He started in the company's Operations Department and has also been in process study, successively as a chemical engineer, corrosion engineer, and group leader.

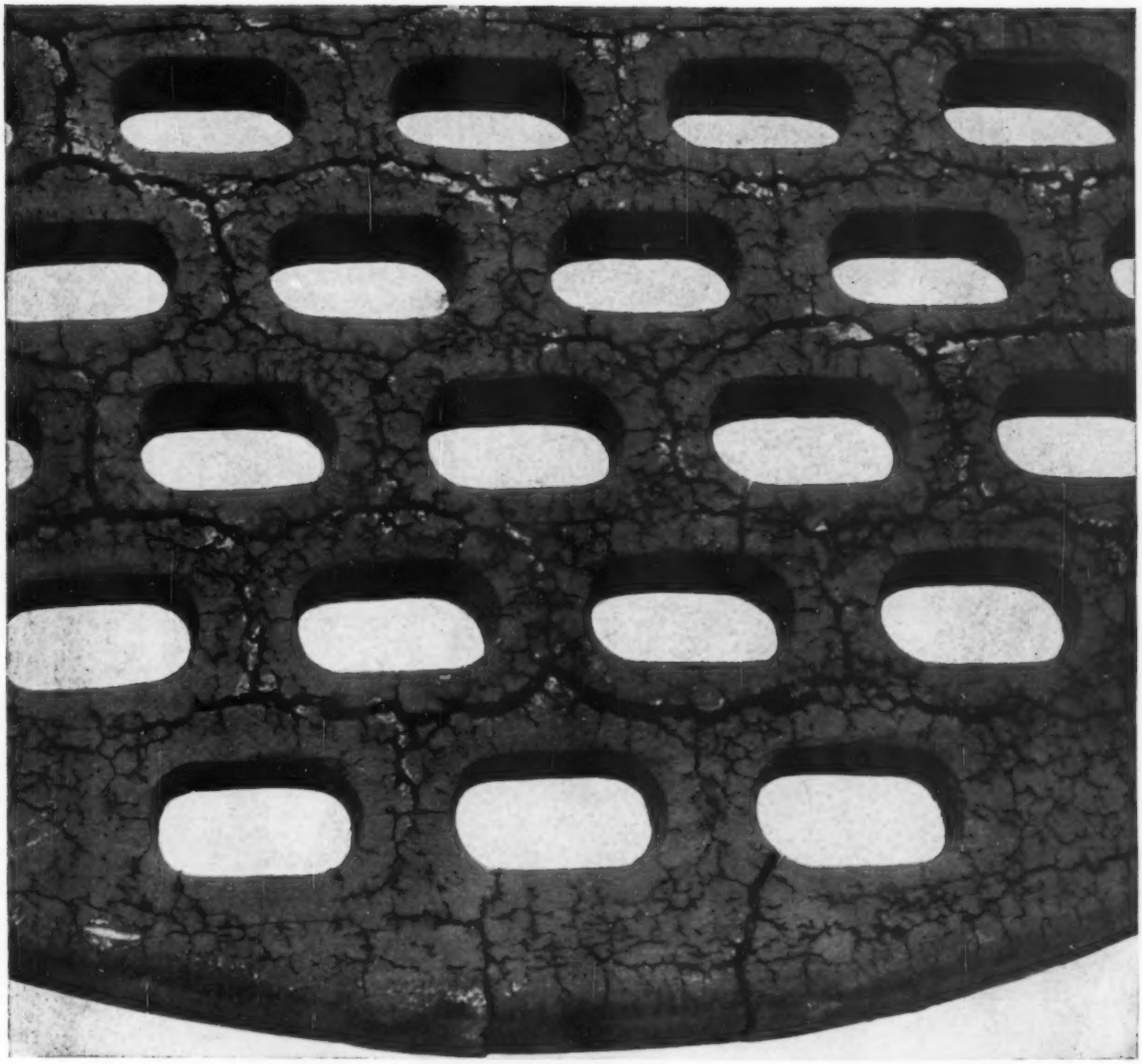
UNITED STATES STEEL PRODUCTS DIVISION has named **J. Patrick Munsch** Sharon District manager succeeding **James A. Connelly,** former division vice president, retired. Munsch became district sales manager at Sharon, Pa., in 1956. He had previously been with the New York office of U. S. Steel Products Division since 1948. He is a graduate of the Metallurgical Engineering Department of Missouri School of Mines, and of Northwestern University, where he majored in business administration.

GENERAL ANILINE & FILM CORP.'s Dyestuff and Chemical Division has established a new and separate Pigment Department. The company previously handled both pigments and dyes as a unit in sales and production. New appointments in the division include **Dr. Leon Katz,** product manager, pigments; **Maurice L. McCord,** Western Regional manager; **John D. Shaw,** Eastern Regional manager; **Theodore B. Smock,** Mid-Western Regional manager, and **Emil A. Wich,** manager, technical services.

GENERAL ELECTRIC CO.'s Chemical and Metallurgical Division has appointed **Dr. Charles E. Reed** general manager succeeding vice president **Robert L. Gibson,** named general manager of the company's Transformer Division, Pittsfield, Conn. Dr. Reed was previously general manager of the company's Metallurgical Productions Department, Detroit. He graduated from Case Institute of Technology with a B.S. degree in chemical engineering, and received his Sc.D. from Massachusetts Institute of Technology.

DOW CHEMICAL INTERNATIONAL, LTD., S.A. has named **Joseph Eveland** plastics sales manager for the European area. **Philip J. Meeks** succeeds Eveland as head of the International Section, Plastics Technical Service. Eveland will supervise sales and determine marketing methods for Dow plastics in European countries (except the United Kingdom) from offices in Zurich, Switzerland. For the past three years, Eveland has directed technical

For more data on advertised products, use Readers' Service Cards, last page.



This is THERMAL FATIGUE

This photograph shows a heat-resistant alloy casting after thermal-fatigue failure.

Thermal fatigue begins with cyclical heating and cooling which produces alternate expansion and contraction. The shape of the casting hinders this expansion and contraction. As a result, hindered expansion and contraction stresses develop and increase until plastic flow occurs. This plastic flow produces a network of thermal-fatigue cracks and this cracking leads to failure.

Thermal fatigue is an inherent problem in heat-resistant castings. As such, it occupies an important place in Electro-Alloys research efforts to lengthen life of components working under high temperatures and severe cyclical conditions.

We have created apparatus that assesses and analyzes the variables of thermal fatigue. Check with your Electro-Alloys representative for the meaning of our thermal fatigue data as it pertains to the material, design and service conditions of your heat-resistant castings.

Send for free technical booklet on Thermal Fatigue

Please send me free copy of "The Mechanism of Thermal Fatigue," by Howard S. Avery—comprehensive report based on extensive lab studies:

Name_____

Title_____

Company_____

Address_____

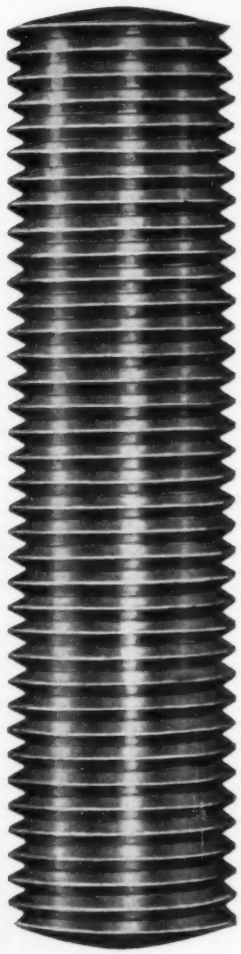
City_____ State_____

Electro-Alloys, 10311 Taylor St., Elyria, Ohio

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION • Elyria, Ohio

There's nothing ordinary about the fasteners illustrated on this page. Bethlehem engineers designed them to resist the high and low temperatures—and the high pressures . . . of refinery bolting. You can depend on them for long life, low maintenance. Full details gladly supplied by our nearest sales office. Or write to us at Bethlehem, Pa.



Bethlehem continuous-thread stud has no point of thread run-out. Stresses can't concentrate at any specific area. Instead, stresses are evenly distributed over the full working length of the stud.

One of these four nuts meets your temperature or pressure requirements. Each meets ASTM Spec. A-194. Each is tapped to Class 2B fit. Each is available in the full size range.

Grade 4, severe temperatures and pressures.

Grade 2H, higher temperatures and pressures.

Grade 2, moderately high temperatures and pressures.

Grade 4L, low temperatures.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Suppliers . . .

service work for Dow European plastics fabricators and users. Meeks, who holds a B.S. degree in management engineering from Rensselaer Polytechnic Institute, joined Dow in 1954, became a PTS field development engineer in 1956 and a customer service engineer in 1957.

ORBIT VALVE CO. has appointed **Ed B. Lockey** sales representative for North Louisiana, Mississippi and South Arkansas. Prior to joining Orbit Valve, Lockey was a service engineer for six years with a large oil tool manufacturer. Before that he spent eight years as assistant engineer and purchasing agent for a Louisiana gas company. Lockey will headquarter at 2907 Oliver, Bossier City, La.

NALCO CHEMICAL CO. has named **Thomas C. Jones** president. **Joseph A. Holmes,** former president, has become vice chairman of the board of directors, Jones has been with the Nalco board since 1953 and the company's Executive Committee since 1954. An executive of Aluminum Co. of America for over 40 years, Jones is manager of its Chicago district.

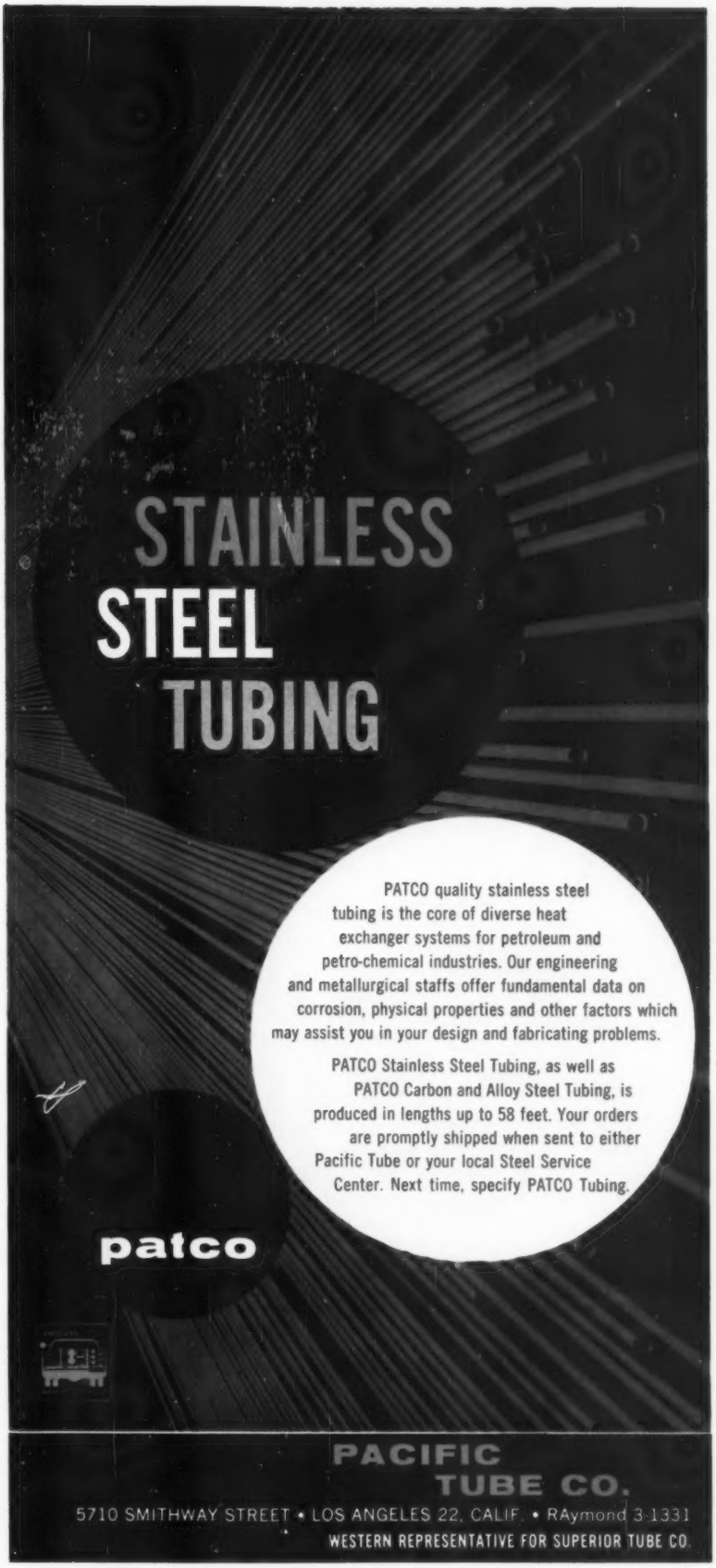
ACF INDUSTRIES, INC. has elected **Russell C. Taylor** president and **James F. Clark** chairman of the Excutive Committee. Clark has been president of the company since 1954. Taylor is taking early retirement at age 55 from American Can Co. as an Executive Department vice president and director. Both are directors of the company—Clark since 1952 and Taylor since 1956.

UNITED STATES STEEL CORP. has named **Dr. Robert F. Mehl** (dean of graduate studies, and head of the Department of Metallurgy, Carnegie Institute of Technology) a consultant for scientific liaison between its research organization and universities and research institutes in Europe. He will assist in the mutual exchange of scientific and technical information for an indefinite period.

PARKER SEAL CO. has named **Albert Wickson** representative for the New England area, including Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island. He attended Washington and Lee University, and was formerly with Remington Rand Division, Sperry Rand Corp., Boston. Wickson will headquarter at Newton Centre, Mass.

INGERSOLL-RAND CO. has elected **W. T. Alderson** vice president. Previously manager of the company's Compressor Engineering Department, he will locate in Ingersoll-Rand's New York executive offices. A 1923 electrical engineering graduate of Johns-Hopkins University, Alderson joined the company in 1927 after service with General Electric Co. as an industrial engineer.

GENERAL ANILINE & FILM CORP.'s Antara Chemicals Division has appointed **Allison K. May** manager of surfactants and related chemicals, and **Eldin S. Underwood** manager of heavy chemicals. May joined


STAINLESS
STEEL
TUBING
PATCO quality stainless steel tubing is the core of diverse heat exchanger systems for petroleum and petro-chemical industries. Our engineering and metallurgical staffs offer fundamental data on corrosion, physical properties and other factors which may assist you in your design and fabricating problems.
PATCO Stainless Steel Tubing, as well as PATCO Carbon and Alloy Steel Tubing, is produced in lengths up to 58 feet. Your orders are promptly shipped when sent to either Pacific Tube or your local Steel Service Center. Next time, specify PATCO Tubing.
patco
PACIFIC TUBE CO.
5710 SMITHWAY STREET • LOS ANGELES 22, CALIF. • RAymond 3-1331
WESTERN REPRESENTATIVE FOR SUPERIOR TUBE CO.

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

Antara in 1957 as manager, heavy chemicals. He previously was manager of sales research and development, Jefferson Chemical Co., Inc., Houston, where he had been since 1947. Underwood joined Antara in 1953 as sales engineer, Western Region sales, and was appointed Eastern Region manager in 1958.

CHICAGO BRIDGE & IRON CO. has elected **Arthur B. Horton** chairman of the board. The directors also elected the president, **E. E. Michaels,** chief executive officer; **R. F. Hendren,** executive vice president and treasurer; and **E. S. Fraser,** manager of plants.

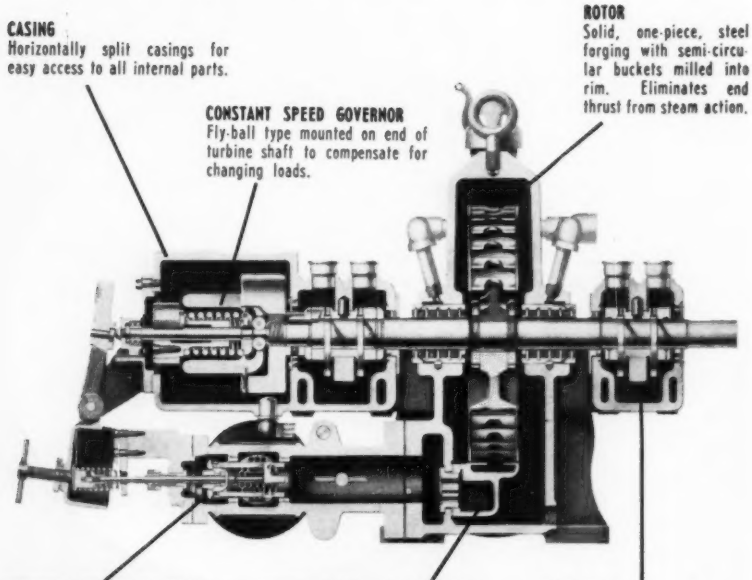
B-I-F INDUSTRIES, INC. has formed Eastern, Central and Western regional operations for its U.S. and Canadian field sales organization. The Eastern Region, with headquarters in New York, is under the direction of **Douglass Taber;** the Central Region is headed by **Paul A. Coffman, Jr.,** who will headquarter in Chicago; and the Western Region is headed by **Edward F. Morey, Jr.,** with offices in Dallas.

BLAW-KNOX CO.'s Buflovak Equipment Division, Buffalo, N. Y., has appointed **Billy C. Werlla** of Werlla Co., sales representative for gas conditioning equipment in Central and South Texas. Werlla Co. is located at 3402 Mercer, Houston.

Whiton

PRECISION ENGINEERED STEAM TURBINES

For almost 50 years, Whiton has combined experience, workmanship and **precision engineering** in building high quality, reliable steam turbines for all types of power and drive applications. Whiton horizontal, helical-flow, single stage turbines are available in 8 wheel sizes. Axial-flow, Curtis-blade turbines are also available. Write for complete data on Whiton's horizontal and vertical turbines.


CASING
Horizontally split casings for easy access to all internal parts.
CONSTANT SPEED GOVERNOR
Fly-ball type mounted on end of turbine shaft to compensate for changing loads.
ROTOR
Solid, one-piece, steel forging with semi-circular buckets milled into rim. Eliminates end thrust from steam action.
GOVERNOR THROTTLING VALVE
Double-seated, balanced V-ported. Admits steam to assure stability control as load varies.
NOZZLE BLOCK AND REVERSING CHAMBER
One-piece unit. 2, 3, or 4 redirecting buckets as required for maximum efficiency.
LUBRICATION
Water cooled oil ring lubrication.

MAXIMUM OPERATING SPECIFICATIONS

POWER	to 1200 HP
SPEED	to 8500 RPM
STEAM PRESSURE	to 1250 PSIG
STEAM TEMPERATURE	to 1050° FTT

THE WHITON MACHINE COMPANY
NEW LONDON, CONNECTICUT

WHEATON BRASS WORKS has opened a sales engineering office in the Fidelity Building, 1940 East Sixth St., Cleveland. **Richard C. Slawinski,** design engineer who has been assistant to Wheaton's vice president of sales for the past three years has been appointed district manager. He joined Wheaton in 1947. Slawinski attended Seton Hall University and received his engineering degree from Stevens Institute of Technology.

DIAMOND ALKALI CO.'s Chlorinated Products Division has named **Martin F. Wilkerson** sales manager, Cleveland. Formerly branch manager of the Southwest District sales office, Wilkerson has 11 years sales experience with Diamond. He started in 1948 as a field salesman in Memphis followed by a promotion to branch manager at Houston in 1955. He holds a B.S. degree in business administration.

SALVO CHEMICAL CORP. has awarded a contract to Panellit Service Corp., Skokie, Ill., for systems engineering in Chicago Sanitary District's new Zimmerman process plant. The Panellit contract involves automatically controlling the air-sludge mixture thru 4 reactors processing 200 tons per day. Excess oxygen content will be used to keep the system's dynamics under control.

MINNEAPOLIS-HONEYWELL REGULATOR CO.'s facility at Beltsville, Md., has been renamed the Industrial Systems Division, a term more accurately descriptive of present and projected activities. The Maryland plant, which produces analog and digital magnetic tape systems and components, had been known as the Davies Laboratories Division since its acquisition in 1956.

FRANK WHEATLEY CORP. has obtained world-wide production facilities for manufacturing pumps and valves through an agreement with Ets Dujardin & Cie, France. The French manufacturing firm will supply companies operating in the oilfields of Central Europe, Africa, and South America. It has a plant in Lille, France, and offices in Tangiers and Buenos Aires.

ARMOUR INDUSTRIAL CHEMICAL CO. has named **Peter E. Macy** derivatives sales representative, St. Louis. His territory will consist of Missouri, most of Iowa, Southwestern Illinois and Northern Arkansas. Macy received his B.S. degree in chemical engineering from Washington University, St. Louis.

NUODEX PRODUCTS CO. has named **Leonard Schaeffer** chief of the Protective Coatings Laboratory. He was previously director of M. J. Merkin Paint Co. Active in technical societies in the paint industry, he is presently secretary of the Technical Committee, New York Paint and Varnish Production Club.

MINNEAPOLIS-HONEYWELL REGULATOR CO. has named **Douglas K. Ridley** contract sales manager for automatic control equipment produced by its Philadelphia-based Brown Instruments Division and other Industrial-Products-Group unit. He

YORK Multi-Stage Turbomaster Ideal For Applications Down To 800 cfm

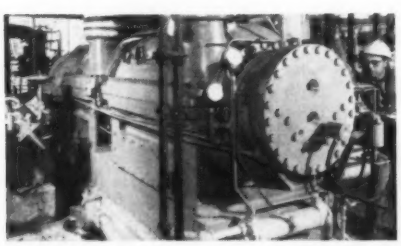
—Offers greater efficiency even for small loads

COMPACT AND ECONOMICAL—On small jobs, Turbomasters offer smoother, pulsation-free operation with virtually no maintenance. On big jobs, two small units can be used, rather than one large machine, to "spare" the system economically.

PRE-ROTATION VANE CAPACITY CONTROL—Standard on all Turbomasters, these vanes provide automatic, continuously variable capacity. This means that compressor capacity stays in direct proportion to load for high system efficiency.

OPERATE BELOW CRITICAL SPEED—Turbomasters up to 6 stages operate well below critical speed. Short, stiff shaft and lightweight aluminum rotors make this possible. Impeller assembly factory-tested at an over speed of 20% or more to insure reliability.

VERSATILE TO MEET YOUR REQUIREMENTS—Up to 8 stages in one casing with choice of casing and rotor materials and sizes, plus side loading and interstage connections to meet exacting requirements. Simple centrifugal design has 400 less parts.



Another YORK Trail Blazer Concept Proved In Action at *Wyandotte Chemicals Co., Geismar, La.*—Two 6-stage 1880 hp turbine driven tandem compressors supply refrigeration for chlorine production. Five suction connections handle 2 loads of condensing chlorine at 2 temperature levels, a water cooling load and 2 stages of refrigerant cooling.

YORK

YORK CORP., SUBSIDIARY OF BORG-WARNER CORP., 5601 SOUTH GRANTLEY RD., YORK, PA.

YORK BW DIVISION

BORG-WARNER RESEARCH & ENGINEERING MAKE IT BETTER

Air Conditioning, Heating, Refrigeration and Ice-Making Equipment • Products for Home, Commercial and Industrial Applications

For more data on advertised products, use Readers' Service Cards, last page.

WHY GAMBLE ON EFFICIENCY?

The initial investment plus the expense of day-to-day upkeep demand that your process heater operate at nothing less than peak efficiency. If it isn't, you're gambling with the cards stacked against you.

The K. W. Anderson Company, whose only business is process heaters, is now offering a series of checks on all types of heaters designed to bring the efficiency curve up where it belongs and keep it there.

Why not let Anderson engineers check your heater for top performance and minimum fuel consumption?

For further information, write:

The K. W. Anderson Company
P. O. Box 660
Tulsa, Oklahoma

Continental United States only.

THE K.W.ANDERSON CO.

Suppliers . . .

will be responsible for contract operations embracing installation and servicing of industrial instrumentation systems. Ridley joined Honeywell's Commercal Division in 1947. He was regional sales manager in Dallas and Chicago prior to his present assignment.

LINDE CO. has completed a new on-site oxygen and nitrogen producing plant to serve Mobay Chemical Co. at New Martinsville, W. Va. This unit will produce 25 tons per day of medium-purity oxygen simultaneously with 25 tons per day of high-purity dry nitrogen. The oxygen will be used in various isocyanate processes.

THE MIDLAND-ROSS CORP. has acquired Surface Combustion Corp. of Toledo and Columbus, Ohio, for $23 million. Surface Combustion is a designer and producer of industrial furnaces, other heating equipment, and dehumidification systems.

CAMROSE TUBES, LTD. has named **C. F. Anderson** president. He is executive vice president and general manager, Page-Hersey Tubes, Ltd., parent company of Camrose. **L. T. Craig** has been named vice president, **W. J. Spencer** treasurer and comptroller, and **H. W. Moore,** secretary.

U.S. INDUSTRIES, INC.'s Solar Chicago Division has named **Burton M. Joseph** general sales manager. With Solar Chicago three and one-half years, he has nine years experience in sales management and sales engineering for capital equipment to the process industries.

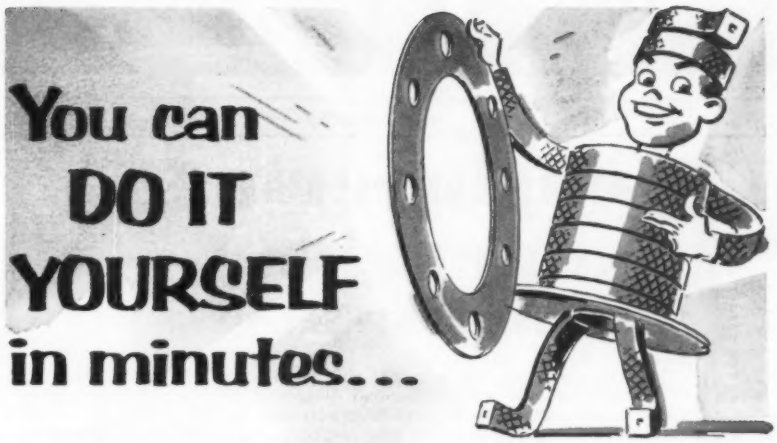
PETROLEUM EQUIPMENT SUPPLIERS Association has elected **H. R. Safford, Jr.,** executive vice president. To maintain headquarters in Houston, he has been executive secretary since 1946. Safford graduated from Yale University with a B.S. degree in industrial engineering.

ALLOY STEEL PRODUCTS, INC., has named **John G. Brady, Jr.,** district sales representative. He has opened offices at 1331 Third Avenue, Seattle, and will cover Washington, Oregon, Montana, British Columbia, and Alberta areas.

JEFFERSON CHEMICAL CO., Houston, has named **Robert J. Barrus** advertising manager. He joins Jefferson after five years with the Advertising Department, Union Carbide Plastics Co. He is a graduate of Fordham University, with a B.S. degree in communication arts and a minor in chemistry.

ETHYL CORP. has named **James B. Lonergan** advertising manager, New York. With Ethyl since 1943, he has been with the advertising staff since 1951. Lonergan has a B.B.A. degree from Manhattan College.

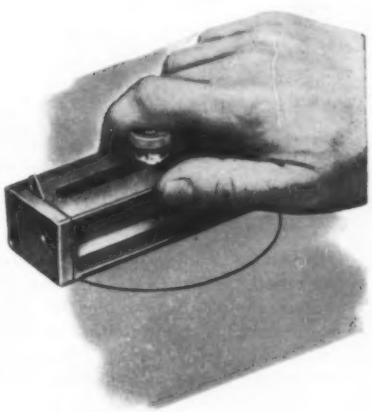
THE AMERICAN ZEOLITE CORP. has changed its name to the Ionac Chemical Corp. Offices will remain at 50 West 44th St., New York.



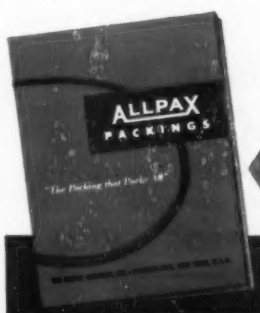
with the ALLPAX Gasket Cutter

Maintenance men from Maine to Mexico have found that they can save hours of costly "down time" with this handy kit. Accurate gaskets can be cut quickly and easily by following a few simple directions—as easily as drawing circles with a compass.

The Allpax Gasket Cutter uses the "ironing principle" to hold material flat during the sweep of the cut, and prevents buckling and tearing common with make-shift devices. All materials in general use as gaskets may be cut to diameters ranging from ¼" to 36" using the popular No. 3 kit. Other kits available for maximum diameters of 12, 24, 48 and 60 inches. Allpax Gasket Cutters and accessory tools are neatly packaged in the permanent metal tool case shown above. An 18" square cutting board is supplied with each kit.



See your local dealer for additional information on the Allpax gasket cutter and our complete line of gasket materials.



ALLPAX

"The Packing that Packs All"

SEND FOR OUR CATALOG — *TODAY!*

A complete line of packing, tools, gasket materials
Distributors in principal cities

THE ALLPAX COMPANY, INC.
160 Jefferson Ave., Mamaroneck, N. Y.
CANADIAN DISTRIBUTORS: Albion Asbestos Packings Ltd., Montreal 18, Quebec

For more data on advertised products, use Readers' Service Cards, last page.

Petroleum Refiner Classified Ads

HELP WANTED

EXTREME LOW TEMPERATURE INTRODUCES CHALLENGING PROBLEMS FOR CREATIVE ENGINEERS — LOW - TEMPERATURE PROCESSING

engineering supervisor

PRESSURE VESSEL DESIGN

The engineer who can fill this position is now completely responsible for the mechanical design of this type of equipment in a small company or has supervisory responsibility at the #2 or #3 level in a larger organization. This engineer will assume technical leadership and direction for the entire group of approximately 40 engineers and draftsmen within the Central Engineering Division of the company. Minimum of 8 years' broad experience in the design of process equipment plus demonstrated supervisory and administrative skills is required. This position also requires experience in the scheduling of engineering manpower, costs, manufacturing techniques in fabricated metals industry and knowledge of ASME Codes.

AIR PRODUCTS designs, develops, manufactures, constructs and operates multi-million dollar chemical processing plants in the low temperature industry. This is a selected position for an engineer interested in a company with outstanding growth record. Backlog of orders and future prospects assure advancement opportunities unusual in industry. Basic steel producers, chemical, petrochemical, refinery, natural gas and defense customers create a broad market diversification. Liberal benefit program including tuition refund. Well evaluated salary structure. Relocation paid.

Please send resume in confidence to
E. J. Strobel, Technical Personnel Manager

80°F — 460°F

Air Products ...INCORPORATED

P. O. Box 538, Dept. 590
Allentown, Penna.

Medium size integrated oil company located in Texas has openings for qualified professional personnel. This is a fast growing company offering advancement opportunities to capable men. Please send resume including references, recent photograph and salary required to Box 329-R, PETROLEUM REFINER, Houston, Texas. Replies are strictly confidential and our employees know of this advertisement.

CHIEF PROCESS ENGINEER

Graduate chemical engineer with minimum seven years refinery experience covering process design and economics.

SENIOR MECHANICAL ENGINEER

Graduate chemical engineer with minimum four years refinery or plant experience. Experience in plant maintenance and preferably some experience in design.

SENIOR PROCESS ENGINEER

Graduate chemical engineer with minimum four years refinery or refinery design experience. Should include plant technical services.

JUNIOR PROCESS ENGINEER

Graduate chemical engineer. No previous experience necessary.

MATHEMATICIAN OR COMPUTER PROGRAMMER

Bachelor of Science graduate with educational emphasis on mathematics or physics, preferably both. No previous experience necessary.

Petroleum Refiner New Classified Rates

RATES: Regular Classified (undisplayed) set in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border $13.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

* * * * * * * *

HELP WANTED

MANAGER

Engineering Contracting Company, well financed, good reputation, needs general manager. Good opportunity available for a man experienced in industrial, petrochemical and refinery engineering and construction.

All replies held in confidence. Submit resume to Post Office Box 2963, Houston 1, Texas.

SITUATIONS WANTED

■ Chemical-Engineer—B.Sc. Ch.E., 1942 M.A.I. Ch.E. Seventeen years experience, process, job, and sales engineer for petroleum refineries and petrochemical plants. Perfect German, some Dutch and Russian. Now senior project engineer in Germany. Desire senior position overseas with engineering or oil company. Box 328-R, PETROLEUM REFINER, Houston, Texas.

FOR SALE

Specify SAUEREISEN
ACIDPROOF CEMENTS—COMPOUNDS
FOR
Tanks, Sewers, Stacks, Floors
Technical cements for all purposes
Send sketches or samples
Sauereisen Cements Company · Pittsburgh 15, Penna

When you see a large chimney think of Sauereisen Cements.

NEW WATERLESS DECALS
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CURE for maintenance headaches...

Maintenance engineers — the men who are responsible for keeping their refineries "on stream" day in and day out—have more than their share of troubles. To them, the installation of efficient, long-lasting, trouble-free equipment is of vital importance. That's why, among other things, they keep looking for better all-purpose small steel utility valves that can be counted on to stand up for long periods of time under ever-increasing temperatures, pressures and corrosion.

In SMITH Forged Steel Valve maintenance men have found a sure cure for their small valve "headaches." SMITH Valves were designed especially for the Refinery and Petro-chemical industries. A combination of special features makes them the finest in their class. "Balanced design," the best quality materials and precision workmanship combine to produce valves that give longer life in service.

Write today for catalog giving complete engineering, material and dimension specifications.

Gates and Globes — OS&Y and Inside Screw — Screwed ends, Socket Weld Ends and Flanged Ends.

Figure 100, above right — the most outstanding forged steel Union Bonnet Needle Globe Valve on the market.

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New England Valve Corp. of Canada, Ltd. Factory & offices: 1 Seneca Avenue • Port Credit, Ontario

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Premium Sheathed Thermocouples
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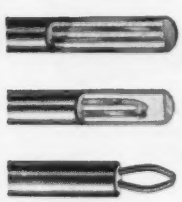
Problems of space limitation, temperature, or pressure are solved with SERV-RITE *premium* sheathed thermocouple wire. For maximum sensitivity, accuracy and quick response, SERV-RITE will furnish the best service for your dollar.

Featuring hard-pack insulation with heavy wall construction, SERV-RITE is fully flexible and can be bent to suit requirements. In addition to a choice of junction tips, fittings and connectors, SERV-RITE *premium* sheathed wire is available in a wide range of sheath materials, bright annealed. Standard and special thermocouples are made to suit any need.

All wires used in SERV-RITE *premium* sheathed thermocouple wire are selected and matched to conform to "Special" limits of error as set forth by I.S.A. Recommended Practice, R.P. 1.3. This wire meets the strictest over-all specifications.



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New Books...

Amino Resins

"Amino Resins" covers the chemistry, manufacture and major applications of urea melamine resins, and the newer ethylene urea and benzoguanamine. The book describes in detail amino resin applications in adhesives, molding, laminating, textiles, paper and surface coatings.

While the author places emphasis on the commercially more important urea and melamine products, he also describes adequately the chemistry and applications of the most recent amino resins based on ethylene urea and the guanamines.

(Blais, John F., *Amino Resins,* Reinhold Publishing Corp., 220 pages, $4.95. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.).

Crude-Oil Analyses

"Bibliography of Reports Containing Analyses of Crude Oils by the Bureau of Mines Routine Method" (Circular 7921) is a reference guide to the more than 3,000 analyses of crude-oil samples in the United States and foreign countries.

A special "finding index" in the bibliography permits a searcher to locate in a few seconds the reference source for specific fields, including many in the Soviet Union and communist-controlled countries. This is because the Bureau's studies date back to 1921 and cover a period when specimens from many foreign countries were readily available for analysis by its chemists.

Although the report emphasizes Bureau publications that have listed the crude-oil analyses, it also contains references to many non-Bureau publications.

(Blade, O. C., *Bibliography of Reports Containing Analyses of Crude Oils by the Bureau of Mines Routine Method (Circular 7921),* Superintendent of Documents, Government Printing Office, Washington 25, D. C., $1.)

Powders and Foams

"A New Method for Determining the Degree of Compatibility of Dry Chemical Powders with Mechanical Foams" (PB 151734) describes a new laboratory test developed by the Navy for measuring the compatibility of dry chemical powders and mechanical foams used for fire fighting.

The test, which eliminates the variable of weather, is a controlled, easily conducted bench procedure.

Measurement of the pH of drained solutions indicated that the ability of the solution to buffer alkaline powders played an important role. In some cases the addition of powder increased the heat-resistant property of the foam.

(OTS, *A New Method for Determining the Degree of Compatibility of Dry Chemical Powders with Mechanical Foams (PB 151734),* Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C., 21 pages, 25 cents.)

Laboratory Test Methods

"Laboratory Test Methods for Petroleum and Its Products," (4th Edition) a basic book on petroleum laboratory technique, describes 89 test procedures meeting the needs of large and small refinery laboratories. Included are spectrophotometric and gas-liquid chromatographic procedures, analytical methods for determination of trace metals, nitrogen and sulfur compounds in various hydrocarbon streams, distillation methods and other tests.

The new edition retains only 39 of the 84 methods described in the 3rd Edition, published in 1953. These have been completely revised for use in the 4th Edition. The 45 methods which were eliminated either have become obsolete or are available as standard tests of ASTM, API. American Public Health Association, and similar organizations. The 50 other methods in the 4th Edition never have appeared previously in the manual. They, too, reflect the latest practices of research laboratories.

Illustration shows some of the more complex apparatus required for some tests. Typical calibration curves, working curves, nomograms and graphs are included.

(UOP, *Laboratory Test Methods for Petroleum and Its Products (4th Edition),* Universal Oil Products Co., Public Relations Department, Des Plaines, Ill., 618 pages, $25).

Reaction Kinetics

"Reaction Kinetics for Chemical Engineers" covers applied kinetics from the viewpoint of the process designer, rather than that of the physical chemist. The treatment of chemical kinetic theory is curtailed to make room for material which the author believes will be of more practical value to the chemical engineer. A mathematical review is included to help readers unfamiliar with differential equations and numerical methods. The descriptive chapters on catalytic processes and various types of industrial reactors will prove particularly helpful to industrial readers and to the beginning student.

Among the subjects treated with more-than-usual detail are: uncatalysed heterogeneous reactions, systematic discussion of heterogenous catalysis, scale-up of pilot plant data, and descriptions and illustra-

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Books . . .

tions of industrial reactors.

(Walas, Stanley M., *Reaction Kinetics for Chemical Engineers,* McGraw-Hill Book Co., 338 pages, $9.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.).

Humble Oil History

"History of Humble Oil & Refining Company" has been published in book form.

The volume traces efforts by the company's administrators and employes to carry on producing, transporting, and refining crude oil and selling crude and products. According to the book, Humble was one of the leaders in the process of transition of the American oil industry from an empirical to a scientific, engineering-oriented industry. The history shows how a growing company undergoing rapid technological change in a highly competitive industry has adapted its personnel, concepts, and techniques to meet new problems and opportunities. The book is illustrated with 32 pages of photographs and 20 maps and charts.

(Larson, Henrietta M. and Porter, Kenneth W., *History of Humble Oil & Refining Company,* Harper & Brothers, 769 pages, $7.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.).

Fire and Brimstone

"Brimstone, the Stone That Burns" tells the story of the American sulfur industry. It contains stories of the early companies, and of the men who built the industry; stories of smart traders in mineral rights, of rugged financiers who backed sulfur against long odds, and of the resourceful engineers who built plants in a sea of sticky gumbo, miles from town or railway.

This book, based on a work published in 1942 entitled *The Stone That Burns,* contains numerous illustrations, including photographs of the original Frasch operations at the pioneering Union Co.

(Haynes, Williams, *Brimstone, the Stone That Burns,* D. Van Norstrand Co., 120 Alexander St., Princeton, N. J., 308 pages, $5.95).

The Embattled Executive

"The Embattled Executive" is a collection of cartoons on selected aspects of executive life. Drawings and text demonstrate how challenging the manager's job really is. This theme is carried out through a little cartoon character who is everything a manager *shouldn't* be. The witty text points out where he goes wrong.

Contents include how executives spend their working day, the executive reading load, how to wreck a conference, the perils of business forecasting, decision making, how to fluff a speech, ten ways to petrify progress and what to do till the doctor comes.

(AMA, *The Embattled Executive,* American Management Association, 1515 Broadway, New York 36, N.Y., 94 pages, $1.25 for AMA members, $1.95 for nonmembers).

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65,000 GALLON PER MINUTE HUDSON COOLING TOWER SUPPLIED IN EMERGENCY

Faced with shutdown of process units because of a damaged, partially inoperative cooling tower, a large Gulf Coast oil refiner called upon HUDSON for emergency supply of new cooling capacity. Despite necessity for modification of HUDSON standard design to conform to existing foundation, and though working under adverse condition of stepwise removal and replacement of partially operating old tower, more than 30 percent of the new HUDSON tower was operating in less than five weeks. The promised time schedule was met, the crisis averted, and guaranteed cooling performance exceeded.

Performance of such special services with speed, ability and integrity is a measure of the quality of HUDSON service — whether in repairing or replacing an operating cooling tower, or in designing and supplying a complete integrated system with balanced use of water and direct air for cooling all process streams.

In addition to water cooling towers, HUDSON designs and manufactures SOLO-AIRE units (for cooling solely with air), and COMBIN-AIRE units (for cooling with combination of maximum air and minimum water). Avail yourself of HUDSON's years of experience in integration of these all-encompassing categories of equipment into cooling systems utilizing optimum ratio of air and water balanced to best meet specific conditions of climate, process, and water availability and quality.

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process stream cooling systems integrating cooling towers, Solo-aires and Combin-aires for optimum balance of air and water cooling.

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Dow Industrial Service will welcome the opportunity to discuss your cleaning problems on all kinds of equipment in all industries—steam generators, process equipment, heat exchangers, towers, water and product lines, water wells and tanks.

The new organization will also offer consulting services, and a line of chemical products for use in water and waste treatment.

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For service or more information call the office or station near you. Or write Dow Industrial Service, 20575 Center Ridge Road, Cleveland 16, Ohio.

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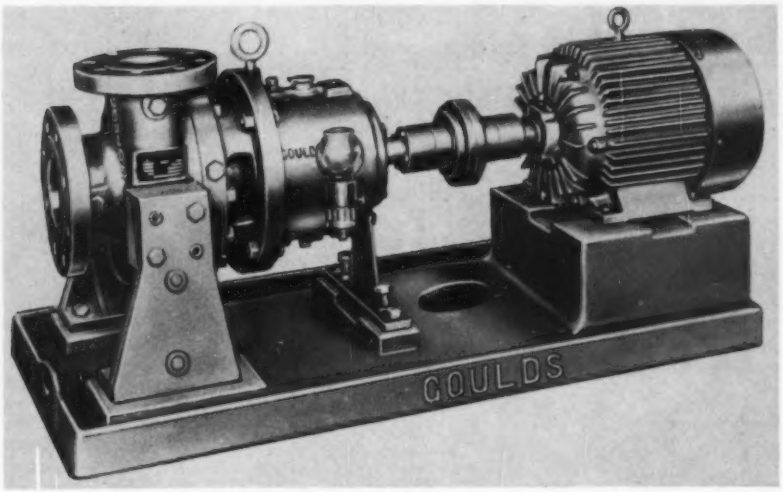


Pump Designed for Most Refinery Uses

A new specialized pump has been designed to meet the specific needs of the petroleum industry and the rigid specifications of API.

Versatility, flexibility, and capability are integral characteristics of these pumps. Built in eleven sizes, the unit offers a broad line of features including pumping capacities up to 1000 gpm and head sizes up to 350 feet. This pump with 300 ASA raised face flanges has a maximum operating pressure to 550 psi and temperature of 600° F. Over 60 percent of all refinery applications are covered in this range.

The pump has a vertical split casing and a center line mount to minimize alignment variations caused by expansion or contraction due to temperature fluctuations. The casing feet are jig drilled and dowelled to the casing. To insure accurate alignment, the casing and casing cover joints are metal to metal, and are sealed at the interior joint by a confined resilient steel and asbestos spiral wound gasket.

The casing cover, containing the seal chamber, casing cover liner and throttle bushing forms the back side of the casing. Cooling chamber of the Figure 3775 is formed by a separate plate completely sealed by "O" rings and held securely in place by a snap ring. This area contains the tapped inlet and outlet connections for circulating the cooling liquid. In order to facilitate minimum maintenance, the plate is removable for cleaning out deposits which may precipitate in the chamber.

Realizing that refinery problems differ, basic seal arrangements are designed to meet various operating conditions.

The future of this type pump, according to many in the petroleum refining business, is extremely bright. More and more, these individuals are showing a preference for processing pump with mechanical seals. Their short impeller overhang coupled with longer and better seal life have made these pumps a most valuable aid for the petroleum industry. Extensive field usage has shown that these pumps will operate efficiently with little maintenance. Goulds Pumps, Inc.

Circle E1 green card, last page

Keep Track of Tank Farm Inventories With Logger

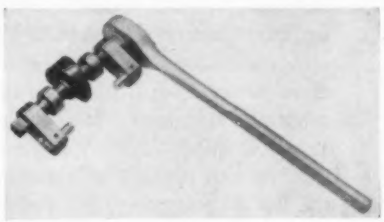
The new Data Master Type 3 Logger, which measures fluids in tanks, checks its temperature and sets off an audible or visual alarm at pre-determined limits, can log data for a complete tank farm—and deliver an automatically typed or punched tape record around the clock.

The unit can also calibrate tanks, gage water interface and monitor a single tank, when required. The Type 3 Logger is of modular construction, 48 inches high, by 24 by 24 inches . . . mounted on casters, complete with top mounted typewriter. Hanson-Gorrill-Brian, Inc.

Circle E2 green card, last page

Flange Spreader Designed For Ring Joint Flanges

The heavy duty Safety Boy Flange Spreader has recently been introduced. This latest model has been



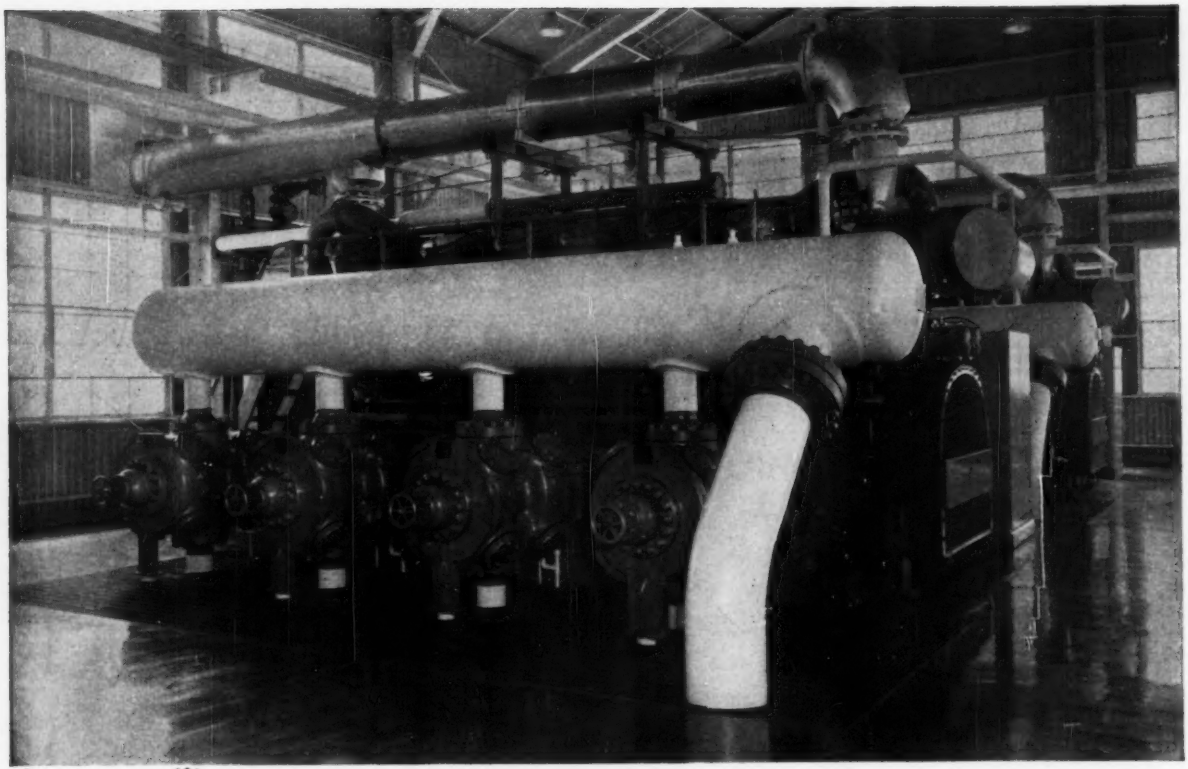
specifically designed to spread ring joint flanges which heretofore have been the "problem child" in pipe maintenance work.

The new Model 104 flange spreader accommodates ASA ring joint flanges ranging from 150 through 1500 pounds. The Wm. L. Riggs Co.

Circle E3 green card, last page

Glass Lined Pipe Can Be Cut To Fit In Field

A revolutionary new Glasteel pipe (glass inside, steel outside) that can be field cut to required lengths, and



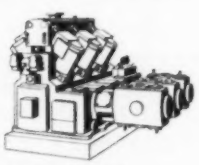
which comes first...

the ENGINE or the COMPRESSOR?

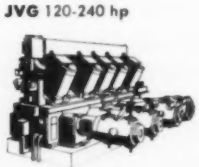
Of course, the power end of a gas-engine compressor is important. The engine cylinders must be capable of delivering smooth power in continuous operation, month after month, with efficiency and economy. And no engine can show better records of long run reliability and sustained efficiency than the Ingersoll-Rand 4-cycle V-angle design. The smooth running characteristics of the I-R 4-cycle engine are well-known.

But don't forget the compressor end; after all, that's what you've really bought—a compressor! The sustained compression efficiency and freedom from maintenance troubles are what make the difference. Ingersoll-Rand has the world's most comprehensive compressor experience, and builds the widest line of units to suit the exact requirements of any application.

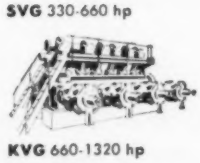
One of the major differences between I-R and other compressors is the valving. I-R Channel Valves are known around the world for efficiency, quietness, and almost unbelievable durability. Each valve is a combination of rigid stainless-steel channels and bowed leaf springs, with trapped-air spaces which cushion action and prevent impact. The separate stainless-steel seat plate can be reversed for double life or replaced, using only simple tools; the I-R Channel Valve is the only compressor valve that can be completely reconditioned in the field without machining. And only Ingersoll-Rand compressors have genuine Channel Valves.



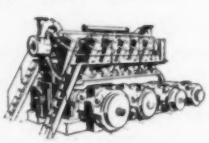
JVG 120-240 hp



SVG 330-660 hp



KVG 660-1320 hp



KVS 1000-2000 hp

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Equipment . . .

that has more than twice the glass thickness of previous glass-lined pipes has been introduced.

Rated at 150 psi and available in 1½, 2 and 3 inch diameters, the pipe offers

wide application in highly corrosive services (all acids, except HF, to 350° F and even to 450° F depending on concentration, and mild alkalies at moderate temperatures). It is also ideal for those applications where freedom from product contamination or adhesion is required. Corrosion resistance and abrasion resistance, which are the primary determinant of service life, are approximately doubled because of the substantially thicker (⅛ inch) boro-silicate glass lining.

The new pipe is priced lower than conventional glass-lined pipe. In addition, the field cutting feature offers significant savings in: (1) less detailed piping layouts, (2) faster installation, (3) more convenient plant piping modifications, and (4) inexpensive maintenance.

The pipe need only be supported in the same manner as carbon steel or other types of iron pipe.

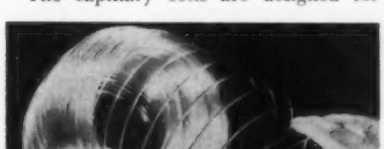
Most of the equipment required for field cutting F-C Glasteel Pipe is standard in industrial plant maintenance shops. The special threading dies and a small fire-polishing furnace are modestly priced. Their initial cost can be rapidly recovered—often during the first installation—from time, material and labor savings realized by the convenient field cutting technique. Pfaudler Div. of Pfaudler Permutit Inc.

Circle E4 green card, last page

Glass Coils Designed For Use In Gas Chromatography

Compact glass coils up to 300 feet in length are being produced for use in gas chromatography.

The capillary coils are designed for

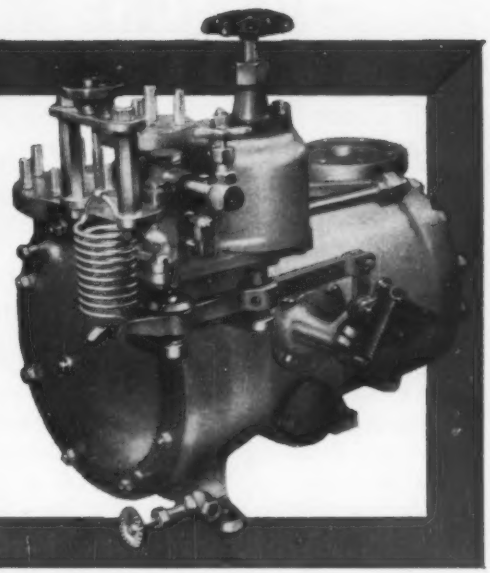


high temperature resolution of com pounds. They will not deteriorate or oxidize at temperatures up to 510° C. Current usage is at maximum of 250° C.

The smooth inside surface of the glass

Complete Pump, Turbine and Controls

COFFIN IND TURBO PUMPS



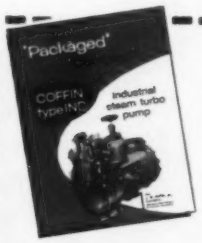
PACKAGED — integral design of the IND Pump results in a compact, highly efficient unit which mounts impeller and turbine wheel on a short, rigid shaft. The unit is equipped with complete controls for constant or differential pressure regulation.

APPLICATIONS — compact and highly efficient, the Coffin type IND Steam Turbo Pump is designed for General Boiler Feed or any other pumping service where medium volume and high pressure is required.

SPECIFICATIONS-

Capacities	to 180 GPM —	Height 32"
Discharge Pressures	to 350 PSIG —	Width 25"
Liquid Temperatures	to 300°F —	Length 32"

For special installations these ratings may be exceeded.



Coffin Turbo Pump Co.
326 South Dean Street, Englewood, N. J.
Gentlemen: Please send me illustrated booklet further describing the Type "IND" Pump.

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GET CLOSER CONTROL OF YOUR NATURAL GASOLINE PROCESS —ASSURE MAXIMUM PROFIT

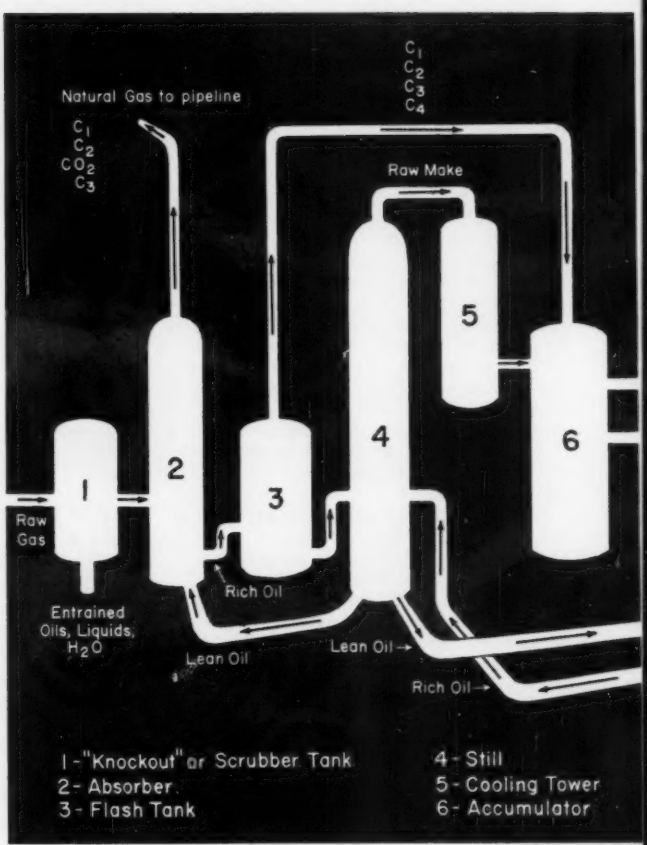
Perkin-Elmer process vapor fractometer automatically signals variations in stream composition

Continuous, reliable, *automatic* process control is a form of profit insurance. Nowhere is this better illustrated than in natural gasoline plants, where any non-uniformity of the process stream usually goes directly into the pipeline and on to the customer.

The new Model 184 Process Vapor Fractometer employs the simplicity and reliability of gas chromatography to provide automatic multi-component monitoring of process streams. The instrument is designed to handle a wide range of gases and light liquids in chemical and petroleum streams.

Developed by Perkin-Elmer with the cooperation of several major oil companies, the Model 184 has been thoroughly field-tested in refinery, petrochemical and natural gasoline applications. Immediate advantages are its low cost*, easy installation, simplicity of operation and maintenance.

The next page shows how the Model 184 Process Vapor Fractometer prevents loss or degrading of product in a typical natural gasoline plant. P-E engineers will be glad to show you how this instrument can improve and then maintain the efficiency of *your* processing operation.



How the process vapor fractometer monitors a natural gasoline stream

In a typical natural gasoline plant processing 300 million cu. ft. of raw inlet gas daily, even minute variations in stream composition can erode profits from two sides. On the one hand are the profit losses that result when a product exceeds specifications in a costly component; on the other, the out-of-pocket losses incurred when the product must be reprocessed or downgraded.

In a natural gas plant there are at least three vital control points where continuous automatic analysis with the Model 184 pays off handsomely:

Deethanizer Bottoms – to cut C_2 and C_3+ fractions with near maximum allowable ethane going to the propane product.

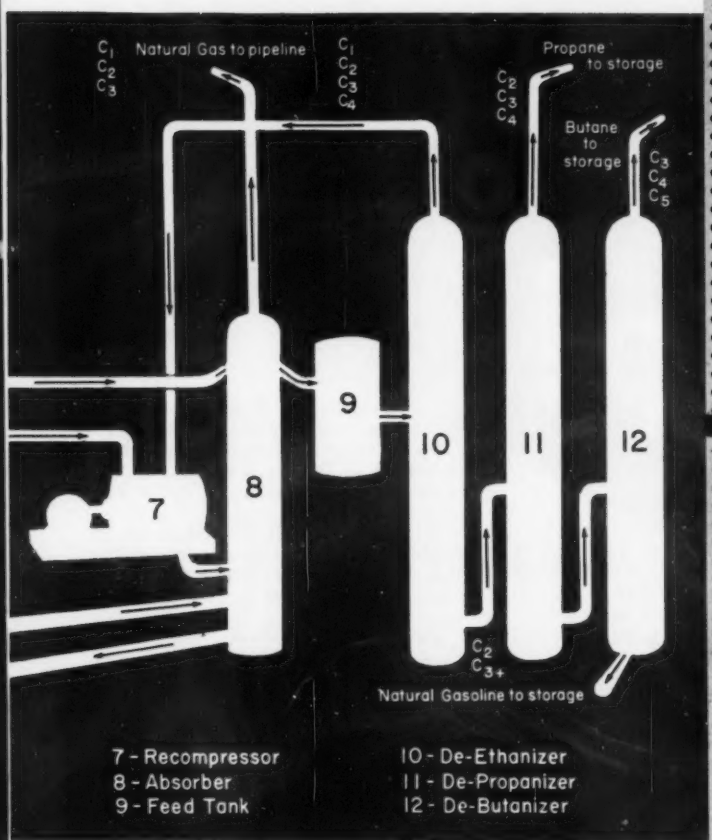
Depropanizer Overhead – to meet, without exceeding, minimum purity of propane spec. In a typical plant, inclusion of 4% ethane can save $16,000 a year at current propane-ethane price differential.

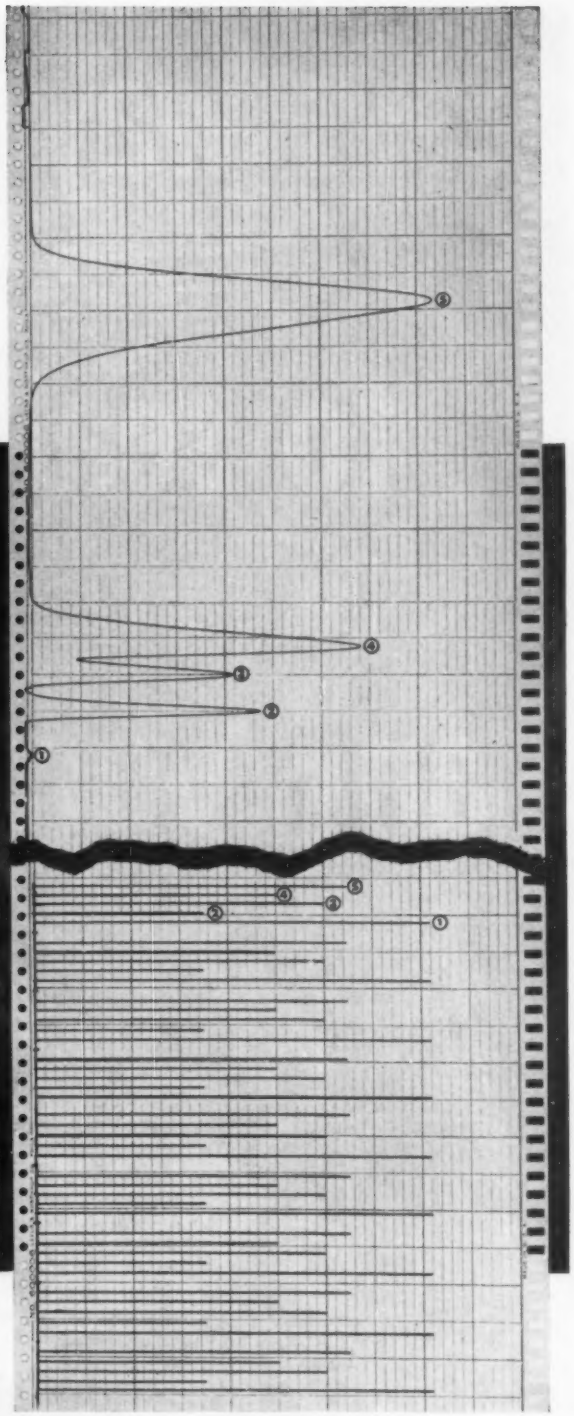
Debutanizer Overhead – to monitor butane product purity, allowing for maximum gasoline volume. Even in a plant of modest size, one hour of below-spec production here can mean reprocessing over 1,600 gallons of product.

*Price $4,950, subject to change without notice.

Fractogram of "raw make" sample (top section, right) illustrates separations attainable on complex hydrocarbon mixtures. Components of interest at this point are (1) C_2, (2) C_3, (3) iC_4 and (4) nC_4. Reverse-flow arrangement (a unique P-E feature) permits C_5+ content to be analyzed as a single peak (5).

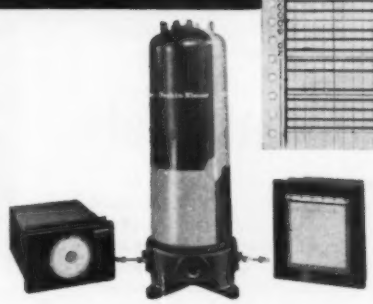
Recorder readout mode is bar chart (bottom section), based on fractogram. Peaks have been variously attenuated for optimum display.





The Model 184 can monitor the process stream at other points—wherever continuous automatic analysis will help to stop profit leaks and maintain product uniformity. Furthermore, this versatile instrument can be used as a general trouble-shooter for analyzing any gasoline plant products.

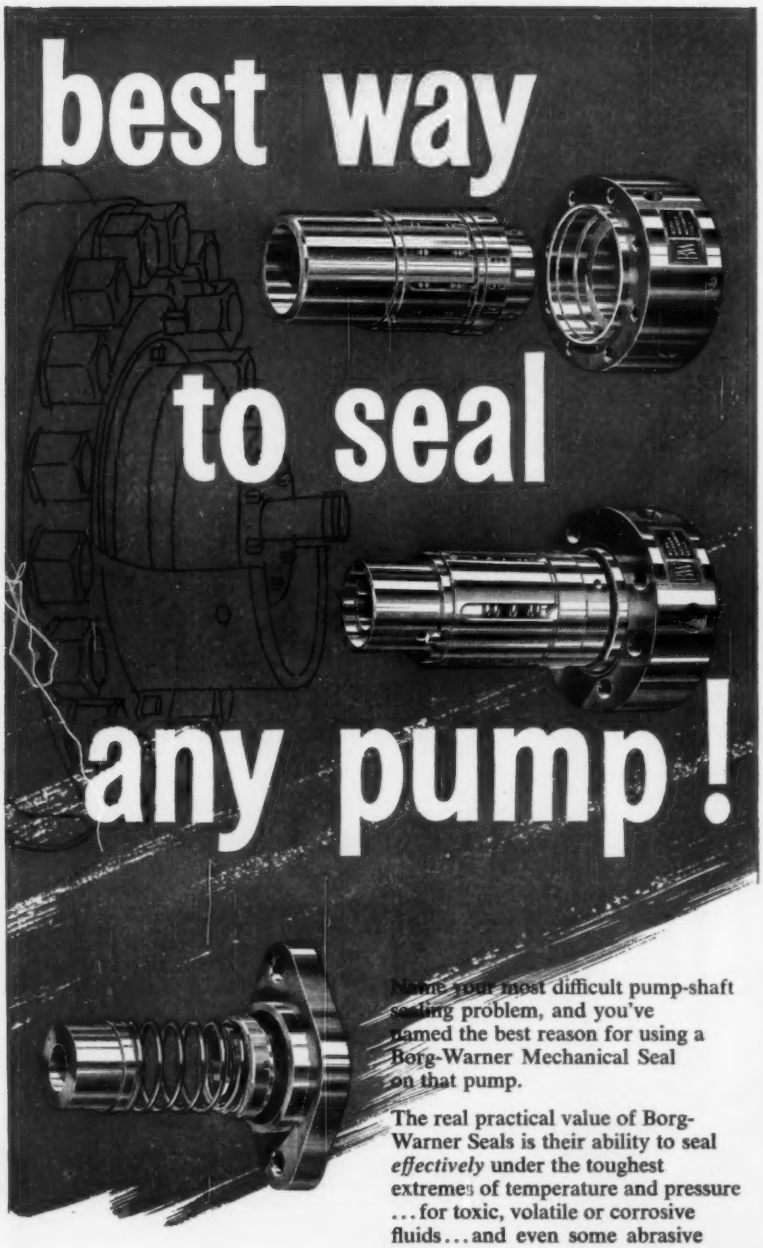
A new brochure, "Automatic Plant Stream Analysis," describes this new instrument system and typical applications where it contributes to process efficiency. Write for your copy to Perkin-Elmer Corp., 880 Main Avenue, Norwalk, Conn.



Perkin-Elmer Model 184 Process Vapor Fractometer. Left to right: programmer, analyzer, recorder.

INSTRUMENT DIVISION
Perkin-Elmer *Corporation*
NORWALK, CONNECTICUT

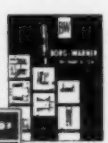
For more data on advertised products, use Readers' Service Cards, last page.



Name your most difficult pump-shaft sealing problem, and you've named the best reason for using a Borg-Warner Mechanical Seal on that pump.

The real practical value of Borg-Warner Seals is their ability to seal *effectively* under the toughest extremes of temperature and pressure ... for toxic, volatile or corrosive fluids ... and even some abrasive liquids. *Result*—less down time, elimination of expensive stuffingbox maintenance, and savings of the pumped fluid.

Borg-Warner Mechanical Seals



NOW AVAILABLE—a new file folder of Borg-Warner Mechanical Seal designs shows some of the many types and applications possible for pumps, mixers, autoclaves and for special rotating shaft problems. Send for your copy today—there's no obligation!

A PRODUCT OF B-W BORG-WARNER

Borg-Warner® Mechanical Seals

P. O. Box 2017, Terminal Annex, Los Angeles 54, California

Equipment . . .

permits application of a thin, uniform grease coating required for effective resolution. The coils are treated to resist abrasion; heavy-walled for mechanical strength.

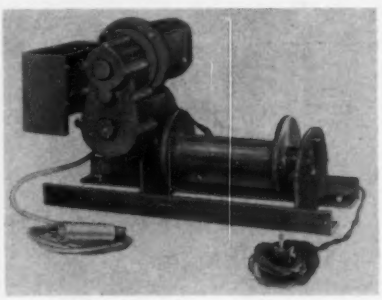
The coils are being made in lengths of 100, 200 and 300 feet with coil I.D. of either 2 or 3 inches. Tubing I.D. can be either .010 or .020 inches. The tubing O.D. is 1/16-inch for uniform size connectors. A 300-foot coil can be placed in a box of 2 inches deep and 5½ inches square. Corning Glass Works

Circle E5 green card, last page

Portable Electric Hoist Can Lift 1,500 Pounds

A new, portable electric winch and hoist, capable of lifting 1,500 pounds, has just been announced.

Weighing only 57 pounds, the My-Te



All-Purpose Electric Hoist operates from any 30-amp, 110-volt AC circuit.

Portability of the new lightweight hoist is insured by its compact size. The unit is only 27 inches long, 12 inches wide and 14 inches high.

Lifting capacity is 750 pounds on a single line and 1,500 pounds on a double line. Drum speed is 59 rpm, and drum capacity is 150 feet of ¼ inch cable. The gear ratio is 280 to 1.

Other features of the new winch-hoist include stress-proof shafts, completely-sealed gear housings, 15 feet of lead cable and a ten-foot remote-control cable with forward and reverse action. City Engineering Co., Inc.

Circle E6 green card, last page

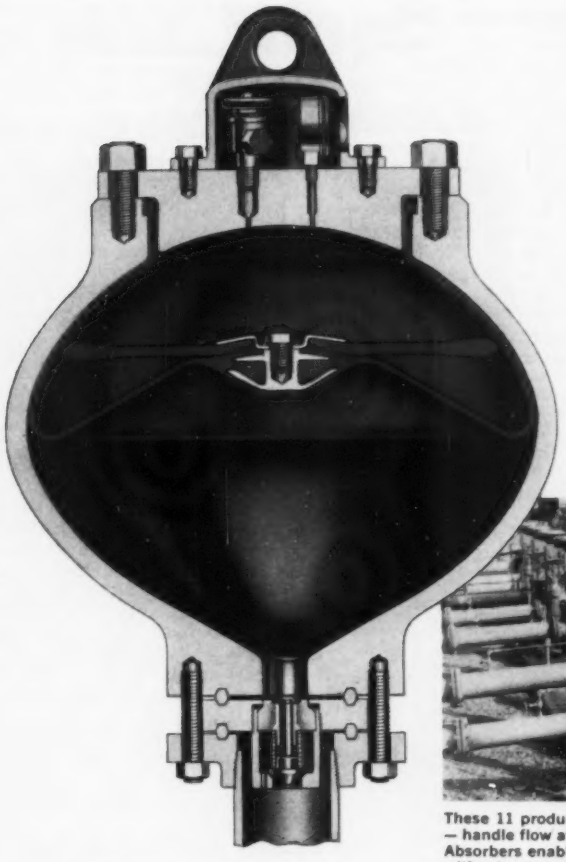
First Electronic Process Control Valve Operator

The first truly electronic process-control-valve operator in the process industry has just been introduced.

The new operator employs neither hydraulic nor pneumatic elements and motor starting, stopping and reversing control are completely electronic operations. There are no mechanical switches or relays.

Frequency response and transfer characteristics are equal to those of pneumatic operators as are the torque and thrust. The new operator is capable of

For more data on advertised products, use Readers' Service Cards, last page.



prolongs life of pipelines, fittings and pumps... saves downtime... cuts maintenance costs!

These 11 product transfer lines — some over 1,000 feet long — handle flow at the rate of 1,600 gpm each, yet Hydril Surge Absorbers enable them to be closed in a fraction of a second without over-pressuring lines, fittings or metering equipment.

HYDRIL TYPE "K" SURGE ABSORBER

smooths out shock and pulsation in pipelines

QUICK-CLOSING VALVES and piston-type pumps punish pipelines by imposing sudden peak pressure loads. Unless these surges can be absorbed or smoothed out, pipe and fittings are exposed to stresses which may cause costly failure.

Hydril Type "K" Surge Absorbers are successfully controlling many types of line surge and pulsation in petroleum product handling lines, water pumping systems and oilwell repressuring programs. Simple design and construction assures long, trouble-free operation. This same oil field-proven Hydril design has been used for many years as a pulsation dampener on high-pressure oilwell mud pumps. Servicing, though rarely required, is readily performed without special tools and without shutting down the system or removing the unit from the line. Available in a wide range of sizes and pressure ratings.

Another dependable Hydril pressure-control product

For more detailed information on Hydril Surge Absorbers, consult your Pipeline or Composite Catalog . . . or call your Hydril Representative

HYDRIL COMPANY

714 West Olympic Boulevard, Los Angeles 15, California

Factories: Los Angeles, Calif.; Houston, Texas

Sales offices: Bakersfield, Los Angeles, Ventura, California; Harvey, New Iberia, Louisiana; Oklahoma City, Tulsa, Oklahoma; Rochester, Pennsylvania; Corpus Christi, Dallas, Houston, Midland, Odessa, Texas; Casper, Wyoming; New York, New York; Calgary, Edmonton, Canada.

For more data on advertised products, use Readers' Service Cards, last page.

stroking speeds up to 3 in./sec. Since the system is fully electronic, response is without valve position hysteresis.

Stroke lengths and speeds are available to meet all valve sizes and process requirements and the new operator is adaptable to plug, butterfly or standard gate valves in addition to conventional control valves. It uses standard AC supply voltages. A maximum of seven wires are required to connect the motor to the control center and there is no susceptibility to noise disturbances in these leads. Industrial Process Engineers, Inc.

Circle E7 green card, last page

Mechanical Seal Resists Organic Compounds, Salts

A new mechanical seal is available composed entirely of chemically inert polymerized plastic, or components loaded or sleeved with this material. The Fluoseal is designed for use with all concentrations of acids and salts, strong oxidizing agents, and is resistant to all organic compounds and salts. The only services for which the seal is not recommended without careful study of the particular applications are those handling strong alkalis such as caustic solutions of more than 50 percent concentration, or acid fluorides such as potassium bifluoride or hydrofluoric acid. Application of the seal is also restricted when a fluid contains solids in suspension.

In the design of the seal, account has been taken of dimensional discrepancies normally encountered in chemical pumps. They are available for ¾ to 3-inch diameter shafts, and there are two versions of the design:

- For external mounting the seal unit is fixed to the shaft with a metal clamping ring, the latter not being in contact with the fluid. In this case only one reinforced end of the bellows acts as a running face.
- For internal mounting a double ended seal is employed and both reinforced bellows ends act as running faces. Crane Packing, Ltd.

Circle E8 green card, last page

Fork Truck Safety Posters For Plant Bulletin Boards

"Think Safety!" This is the theme of a series of sixteen (16) new safety posters just published which illustrate how accidents involving fork trucks occur and how to prevent them. Each poster is designed to emphasize the importance of safe driving practices, by fork truck operators, in order to prevent injury to himself, plant personnel, or damage to the material being transported, plant equipment and the truck.

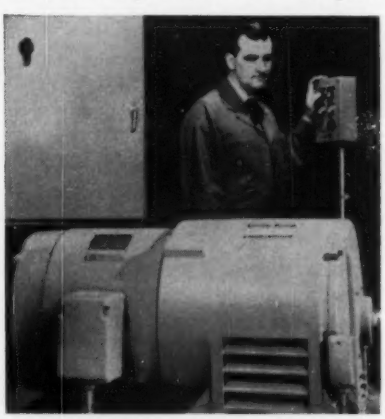
The safety posters, which measure 11 x 17 inches, are suitable for display on any plant bulletin board, houses and shipping docks. They are available free of charge. Automatic Transportation Co.

Circle E9 green card, last page

Eddy-Current Coupling Drives Match Pump Load

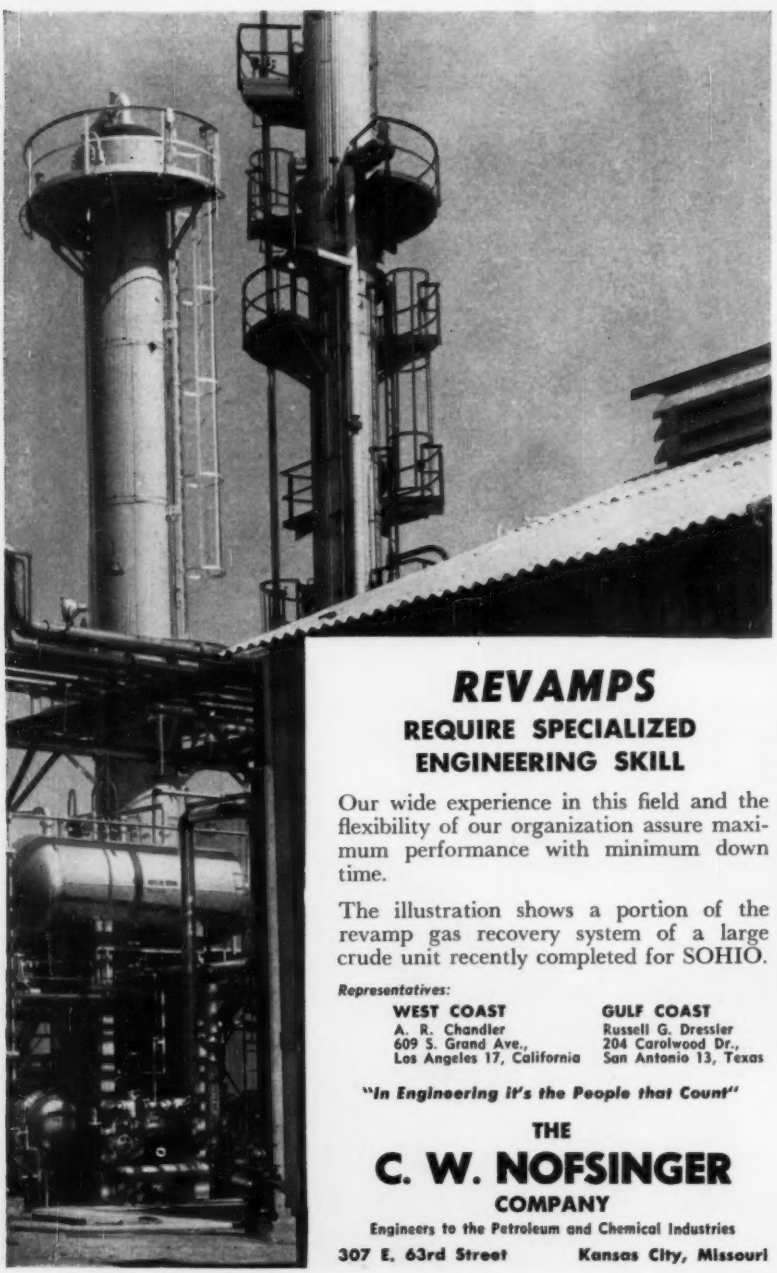
A new, low-cost line of eddy-current coupling-adjustable speed drives from 5 to 100 horsepower has just been announced.

The new stepless adjustable speed-drive is being offered as a complete



package including the drive unit, control enclosure with control for both coupling and integrally mounted AC motor, and operator's station.

The Kinatrol drive offers versatile performance over a constant-torque speed range. Ratings through 20 hp are capable of continuous operation down to 100 rpm at rated torque, providing a speed



REVAMPS
REQUIRE SPECIALIZED ENGINEERING SKILL

Our wide experience in this field and the flexibility of our organization assure maximum performance with minimum down time.

The illustration shows a portion of the revamp gas recovery system of a large crude unit recently completed for SOHIO.

Representatives:

WEST COAST
A. R. Chandler
609 S. Grand Ave.,
Los Angeles 17, California

GULF COAST
Russell G. Dressler
204 Carolwood Dr.,
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"In Engineering it's the People that Count"

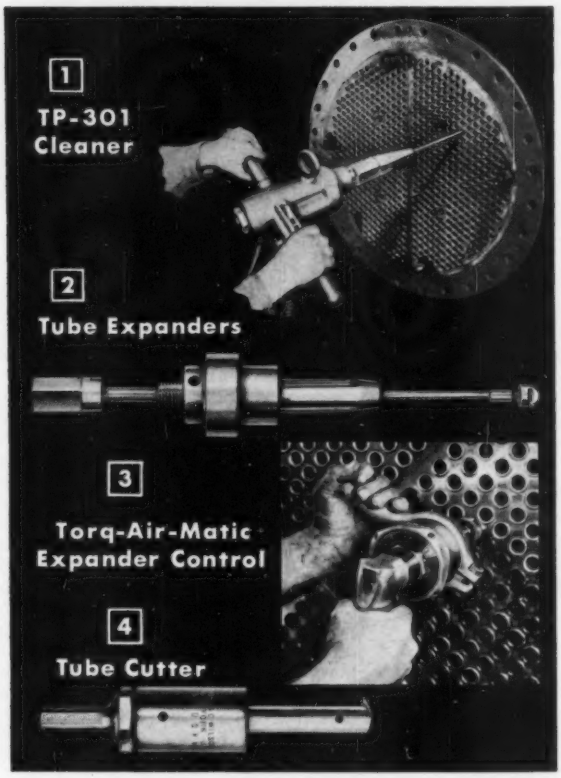
THE C. W. NOFSINGER COMPANY

Engineers to the Petroleum and Chemical Industries

307 E. 63rd Street Kansas City, Missouri

Keep Heat Exchangers on stream with

WILSON TUBE MAINTENANCE TOOLS



1 Heavy-duty TP-301 Cleaner is a positive air-driven, hollow rotary shaft, drill type tool. Tube is scavenged with air or water while cleaning.

2 Wilson Models 41 and 44 Tube Expanders incorporate an improved, adjustable ball bearing thrust collar and are designed for efficient, easy rolling and maximum roll length adjustment for various tube sheet thicknesses.

3 New Wilson Torq-Air-Matic is the first and only air-driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel.

4 Wilson tube cutter is easy to use and does a fast job. Cutter sizes and shanks available to meet all heat exchanger requirements.

Write today for your copies of Wilson Tube Cleaner catalog No. 77 and Wilson Tube Expander catalog No. 88. TW-001

Representatives in principal cities

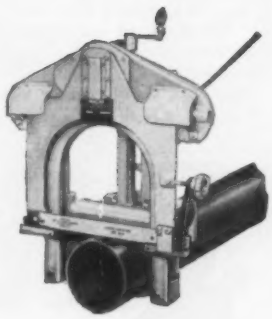
THOMAS C. WILSON, INC.
21-11 44th Ave., Long Island City 1, N. Y.
Cable address: "Tubeclean", New York

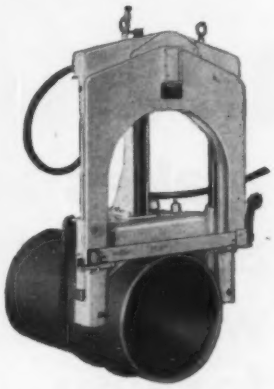
WILSON
TUBE CLEANERS • TUBE EXPANDERS

Here are tools you need for

MAINTENANCE!

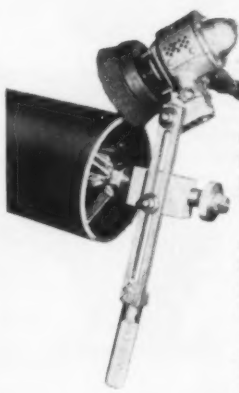
Wachs Guillotine® Saw cuts steel, cast iron or stainless pipe. Model C, capacity 2" to 8". Also cuts bar stock, structurals and rail. Electric or Air Drive.





Big Guillotine,® Model D cuts 10" thru 16" diameter. V-Base assures square cut every time. Fast-Safe-Accurate. Electric or Air Drive. Machine fits in very tight places and cuts in any position.

Wachs National Pipe Saw, "the Milling Machine on Wheels" travels around the pipe. Makes fast, accurate and safe cuts on steel, cast iron or cement-lined pipe. Cuts bevels for welding. Machine adjusts to all sizes from 10" to 72" diameter.



BEV-L-GRINDER

Easy to operate and extremely fast and accurate, the New Wachs Bev-L-Grinder produces clean faced uniform weld bevel preparation without making any change in the physical properties of steel pipe.

Self-centering, internal expanding mandrel provides a spindle to guide the Bev-L-Grinder head assuring accurate weld preparation because grinder travels in true plane.

These factors make good line-up and fit easier to obtain in the field. This makes it possible for field crews to get the highest quality welds.

Write for descriptive bulletins

THE E. H. WACHS COMPANY
Manufacturers of Engines, Valves and Machinery since 1887
1525 NORTH DAYTON STREET • CHICAGO 22, ILLINOIS

Equipment . . .

range of approximately 17 to 1.

Automatic control provides close speed regulation as standard. On a typical friction-type load, for example, regulation of 2 percent of full speed can be obtained with standard equipment.

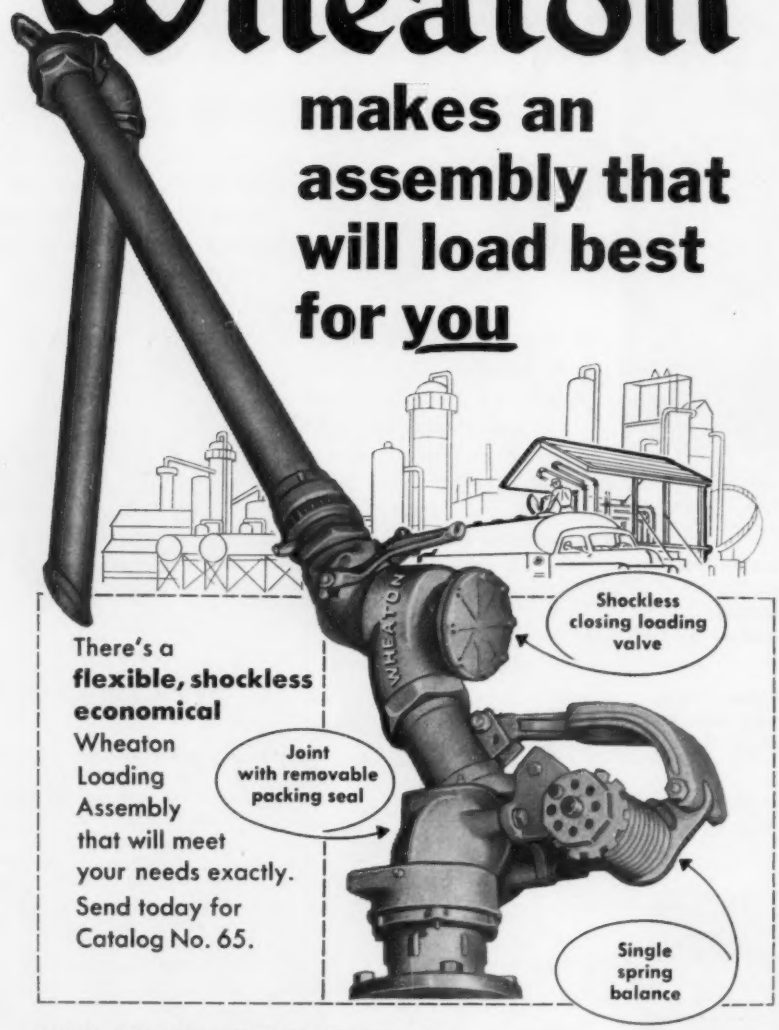
The Tri-Clad 55 motor and eddy-current coupling-adjustable speed member are integrally designed to provide an unusually compact drive unit.

Elements of packaged Kinatrol line include drive unit (foreground), enclosure control (upper left), and operator's control station. General Electric Co.

Circle E10 green card, last page

Wheaton

makes an assembly that will load best for you



There's a **flexible, shockless economical** Wheaton Loading Assembly that will meet your needs exactly. Send today for Catalog No. 65.

WHEATON BRASS WORKS, UNION, N. J.

Manufacturers of Loading Arm Assemblies, Swing Joints, Loading Valves, Storage Tank Fittings and Truck Tank Equipment for the Petroleum and Chemical Industries

Foreign Manufacturers

Emco Limited, London, Ontario, Canada • Emco Brass Mfg. Co. Limited, Margate, Kent, England
Emco G.M.B.H., Allendorf, Germany • Ljungmans, Malmo, Sweden
Baza S.R.L., Buenos Aires, Argentina, S.A.

Computer Serves Business And Technical Needs

A new, fully transistorized, general purpose digital electronic computing system which can serve both scientific and business data processing needs has been announced.

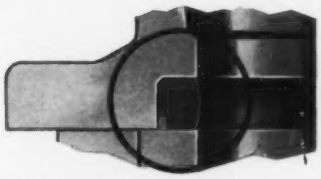
The computing system is capable of operating on 9-digit numbers at rates up to 240,000 operations per minute. This has been accomplished by incorporating new design concepts, rather than by adding expensive hardware. Over-all high computing speed results from: high operating rates; versatile command list (42 in all) including commands which facilitate double-precision and floating-point operations as well as a special command designed to speed-up input and output operations; an index register that allows high-speed instruction modification; repeat execution feature; high-speed input-output equipment and an 8-word accumulator for block operation (eight sums may be accumulated simultaneously).

The magnetic drum memory section incorporates many new design features. The entire unit is encased in a metal shroud to protect it from dust particles or accidental damage. The drum is tapered and floats on a cushion of air. When the machine is idle, the drum rests safely away from the heads. Air pressure automatically raises the drum to correct operating position when power is turned on. Physical size has been kept to a minimum by the use of miniaturized heads. The memory has a storage capacity of 8,008 words (word length is 32 usable bits, accommodating a 9-decimal digit number), allowing great problem-solving flexibility. A variety of programs can be stored permanently for instant access when needed. Average access time to the main storage is 8.5 milliseconds. Memory may be searched for full or partial words (through special masking feature) at a sustained rate of nearly 200,000 words per minute. Three thousand words of memory can be scanned in less than one second for full or partial equality to a key word or full or partial equality or superiority to a key word. Part of memory (136 words) is available through the high-speed line or dual access tracks in from 1 to 6 milliseconds.

The main memory is non-volatile. Switches allow information to be locked in the main memory in increments of

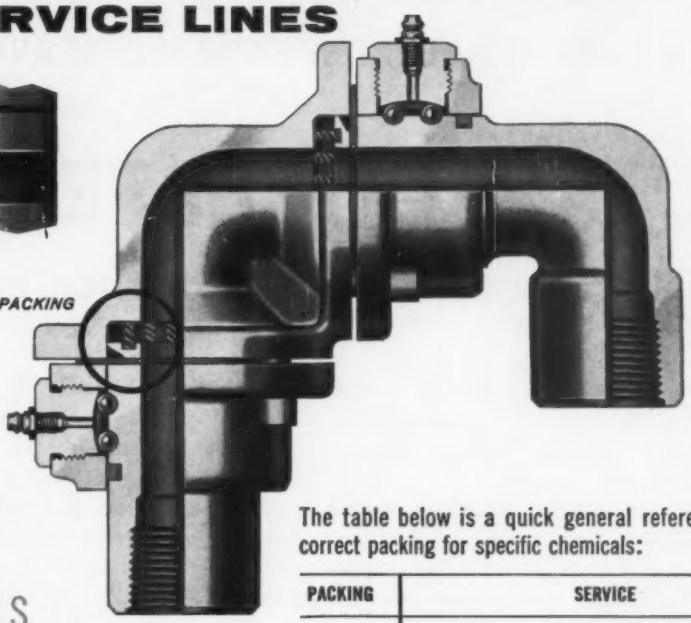
NEW CHIKSAN SWIVEL JOINT

GIVES SAFE, LASTING FLEXIBILITY TO CHEMICAL SERVICE LINES



VIEW ABOVE SHOWS MOLDED PACKING

VIEW AT RIGHT SHOWS DISC PACKING



INTERCHANGEABLE PACKING FEATURE ENABLES **DS SERIES** TO HANDLE A WIDE RANGE OF CHEMICALS IN SERVICES FROM –65°F TO +400°F AT 300 PSI

The DS Series swivel joint with its broad service range can be a valuable new tool in your process system. Use it in chemical loading of tank car or tank truck, for stress relief in piping subjected to vibration, expansion or settling, or as a steam rotation connection between stationary and revolving equipment. Wherever you use it, you'll find it pays for itself in extended service life.

Using a disc or molded type packing, this swivel joint can be applied to handle steam and any of a wide variety of chemicals processed in your plant. And the split segment feature of the DS Swivel Joint allows replacement of packings without removing the joint from the line.

Buy and apply Chiksan DS Series Swivel Joints for chemical service lines in your plant now. You can select from eight basic styles for full rotation in one, two or three planes. For more information write to Chiksan or fill in the coupon below.

The table below is a quick general reference for the correct packing for specific chemicals:

PACKING	SERVICE
Neoprene	Recommended for alkaline and acid salt solutions and aldehydes such as formaldehyde.
Hycar	These should be used for petroleum derivatives, neutral or slightly acidic salt solutions, dilute acids (Sulfuric to 50%, Hydrochloric and Nitric to 20%), alcohols, glycols, ethers, gases (Oxygen not over 500 psi), and vegetable oils.
Butyl	Recommended for liquid or anhydrous ammonia, gases (except oxygen over 500 psi), ammonia derivatives such as hydrazine and for certain hydraulic fluids such as Pydraul, Skydrol, and Cellulube. It is recommended for acetone and methyl ethyl ketone.
Teflon*	Used for concentrated or fuming acids and other highly oxidizing fluids, esters, aromatics, liquid chlorine, bromine and fluorine if temperature is not excessive.
Asbestos	For use in saturated steam service.
Viton "A"*	Recommended for use with concentrated acids, aromatics, liquid chlorine, liquid bromine, chlorine or bromine derivatives, molten sulfur, and carbon disulfide.
Metallic	For extreme services such as hot gas at 600°F., a Stainless Steel metal disc, specially treated to prevent galling, is recommended.

* R.T.M. DU PONT

CHIKSAN COMPANY, 330 North Pomona Ave., Brea, California

Please send me copy of Bulletin No. 1258

Name_____

Company_____ Title_____

Address_____

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#59-46

CHIKSAN fmc

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

CHIKSAN COMPANY—Brea, California • Chicago 5, Ill. • Newark 2, N.J. • Weco (Division), Houston 24, Texas • Subsidiaries: Chiksan Export Co. • Chiksan of Canada Ltd.

GET PREDICTABLE, DEPENDABLE SERVICE EVERY TIME . . .

FARROWTESTED

Heat exchanger tubing . . . carbon and stainless steels

Get predictable, dependable service everytime. Specify Republic ELECTRUNITE® Heat Exchanger Tubing which has passed the most searching test of all—FARROWTEST®.

FARROWTEST is Republic's exclusive non-destructive eddy-current test that probes for and detects injurious defects so small that they pass ordinary internal fluid or gas pressure tests. FARROWTEST looks deep within the tube wall, is calibrated to reject tube with defects as shown in the table below.

FARROWTEST is offered as an alternative to other less positive tests at no increase in cost. Carbon steel Heat Exchanger Tubes produced to ASTM specification A-214; stainless steel Heat Exchanger Tubes to A-249. Both specifications include eddy-current requirements.

As a tube buyer and user, you owe it to yourself and your company to get ELECTRUNITE and FARROWTEST facts firsthand. Call your Republic representative. Or, write direct.

FARROWTEST REJECT TABLE

Wall Thickness (B.W. Gage)	Minor dimension of the defect (Length or Depth)	Defective Area (Length, Depth Plane)
20	.006″	.0025 sq. inches
18	.006″	.003 sq. inches
16	12½% of wall	.003 sq. inches
14 and 13	12½% of wall	.004 sq. inches
12 and heavier	12½% of wall	.005 sq. inches

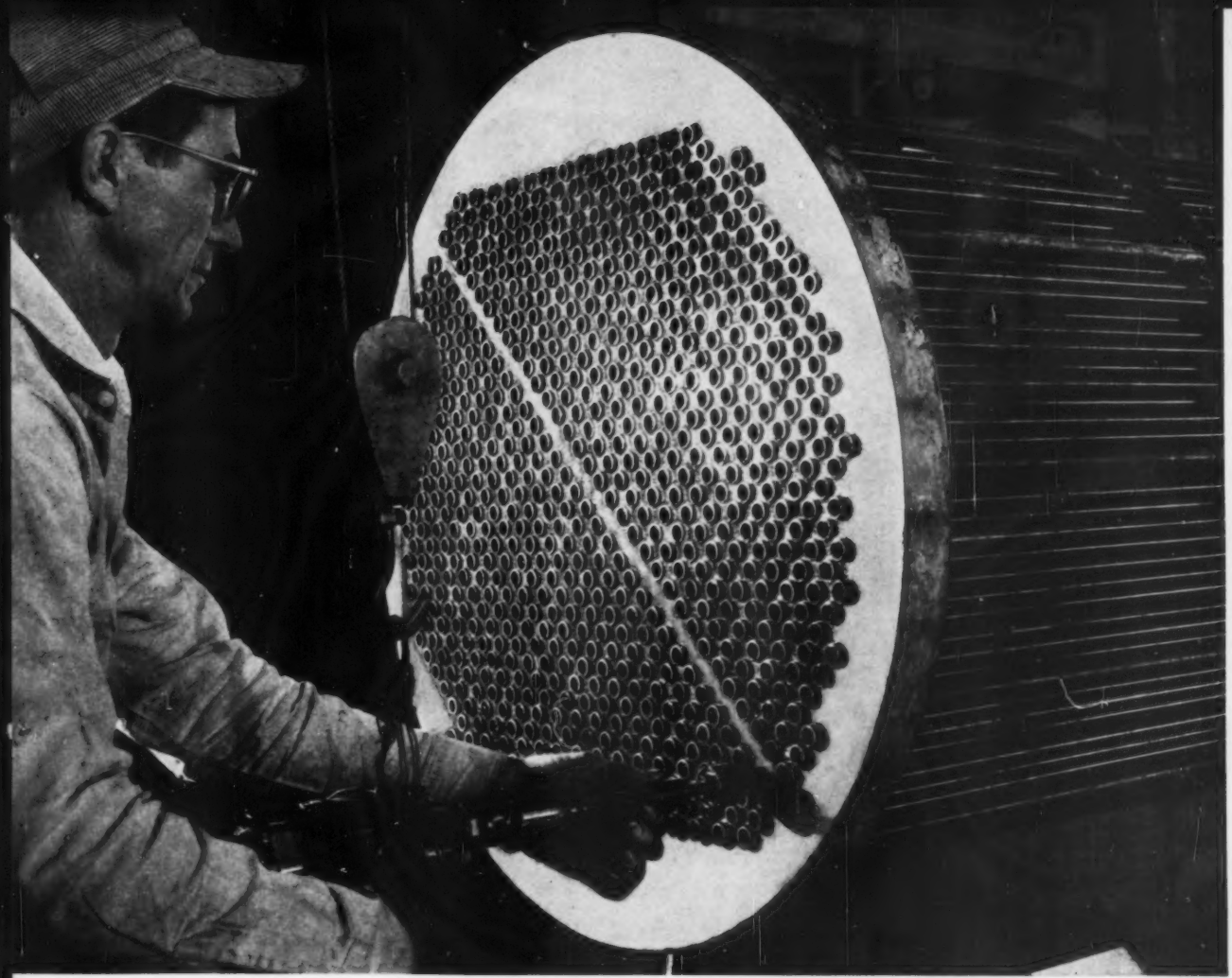
FARROWTEST detects and rejects not only tubing containing defects which completely penetrate the wall; but also tubing with defects equal to, or greater than, those shown in this table. For irregular defect shapes, a tube with defect area equal to or greater than shown above is rejectable. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.

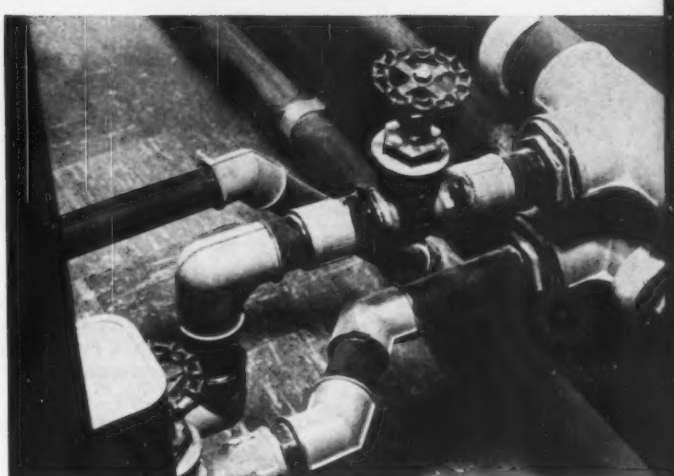
FARROWTEST—quality measured for you. Not a laboratory theory, not a mere inspection tool, but an exclusive production test that detects and rejects tubing containing defects of critical size. FARROWTEST is offered as an alternative to other less positive tests in accordance with the table, at right, at no extra cost.

REPUBLIC STEEL

DEPT. PR-8834 • 1441 REPUBLIC BUILDING

CLEVELAND 1, OHIO





REPUBLIC SRK PLASTIC PIPE is extensively used to make up spray headers and bars in cooling towers. SRK resists corrosion and scale build-up. It is tough yet light in weight and easy to handle, and eliminates heavy supports required with conventional piping. SRK also is widely used for carrying corrosive fluids and wastes.

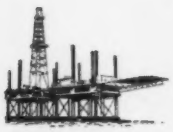
REPUBLIC ALLOY STEEL STUDS AND HIGH CARBON HEX NUTS provide the strength needed in high pressure equipment. High tensile strength with tough threads offers maximum holding power and resistance to wear. Tighten smoothly, back-off easily. Write for data and details.

from the makers of Dimetcote...

ZINKOTE

THE FIRST 100% INORGANIC *SELF-CURING* ZINC COATING...

- A radically new concept in zinc coatings for protecting steel.
- Under development for many years and first patented in 1957.
- Applied in one coat – completely self-curing.
- Can be used wherever galvanizing is satisfactory – actually gives superior protection.
- Completely nonflammable, nontoxic.
- Insoluble in all petroleum products.
- Outstanding resistance to weathering, salt and fresh water.
- Applied by brush, spray or roller.
- Cathodically protects steel.
- Resists temperatures up to 600°F.
- Complete protection for as little as 5¢ per square foot material cost.



How does Zinkote compare with Dimetcote?

Although similar, each has certain unique advantages depending upon the particular requirements of the job. We will be glad to give you a specific recommendation.

For complete information write . . .

Amercoat CORPORATION

Dept. VA • 4809 Firestone Boulevard • South Gate, California

921 Pitner Avenue, Evanston, Illinois
360 Carnegie Avenue, Kenilworth, New Jersey
2404 Dennis Street, Jacksonville, Florida
6530 Supply Row, Houston, Texas

119A

The Pioneer Manufacturer of Inorganic Zinc Coatings.

Equipment . . .

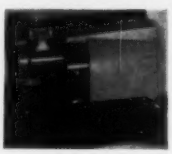
1024 words—so that it cannot be altered by program or operator error. The arithmetic and control section of memory includes three one-word registers, and one "one-or-eight" word register. When used in conjunction with the repeat execution feature, the "one-or-eight" word register provides for block arithmetic and block transfers without special commands.

Standard input-output equipment for the RPC-4000 is a tape typewriter system complete with typewriter, desk, tape punch-read console and chair, all specially designed as a unit. Basic reader speed is 60 characters per second, basic punch speed is 30 characters per second. A reversible photo-electric reader, which reads punched paper tape at 500 characters per second, and a high-speed punch (300 characters per second) are available as optional accessories for system expansion. All of the paper tape equipment includes full tape handling reel facilities.

The RPC-4000 will be available at a monthly rental of $1,750, or a total sales price of $87,500. This includes the computer and the tape-typewriter system. Royal McBee Corp.

Circle E11 green card, last page

Chemical Feed-Pump Meters Highly Corrosive Chemicals



A new, low cost electrically - driven Chem-O-Feeder for the accurate proportioning of concentrated corrosive chemicals has just been announced.

The diaphragm-type pump is made of corrosion-resistant materials and will effectively meter such chemicals as 66-degree-Baumé sulfuric acid, sodium hydroxide, phosphoric acid, photographic solutions, hydrofluosilicic acid, etc.

The positive displacement pump is easily installed, either floor, shelf or wall-mounted, and takes suction directly from the shipping container. Its range is over four to one with a capacity up to .7 gph into discharge pressures up to 100 psig. The complete package ready for installation consists of the pump, foot valve, injection nozzle, connecting hoses and instructions. B. I. F. Industries, Inc.

Circle E12 green card, last page

12-Page Bulletin Has Graphite Exchanger Data

A new 12-page illustrated bulletin on Karbate impervious graphite immersion heat exchangers and circulating steam jets for heating or cooling corrosive solutions in all types of tanks is available.

Separate sections on plate, bayonet, and coil-type immersion heat exchangers include general descriptive, installation, and operation information. Dimensioned sketches of each type give complete construction details, and tables present information on weights and effective sur-

Photographed at Standard Oil of Ohio, (Toledo Refinery)

The constant challenge and the continuous answer

The demand for ever-superior fuels from refiners is constant. The search for ever-better catalysts to help produce these fuels is continuous. At the oil companies and at Cyanamid, the searchers have found that each challenge can best be met by pooling knowledge and resources. In a word, the continuous answer lies in *cooperation*.

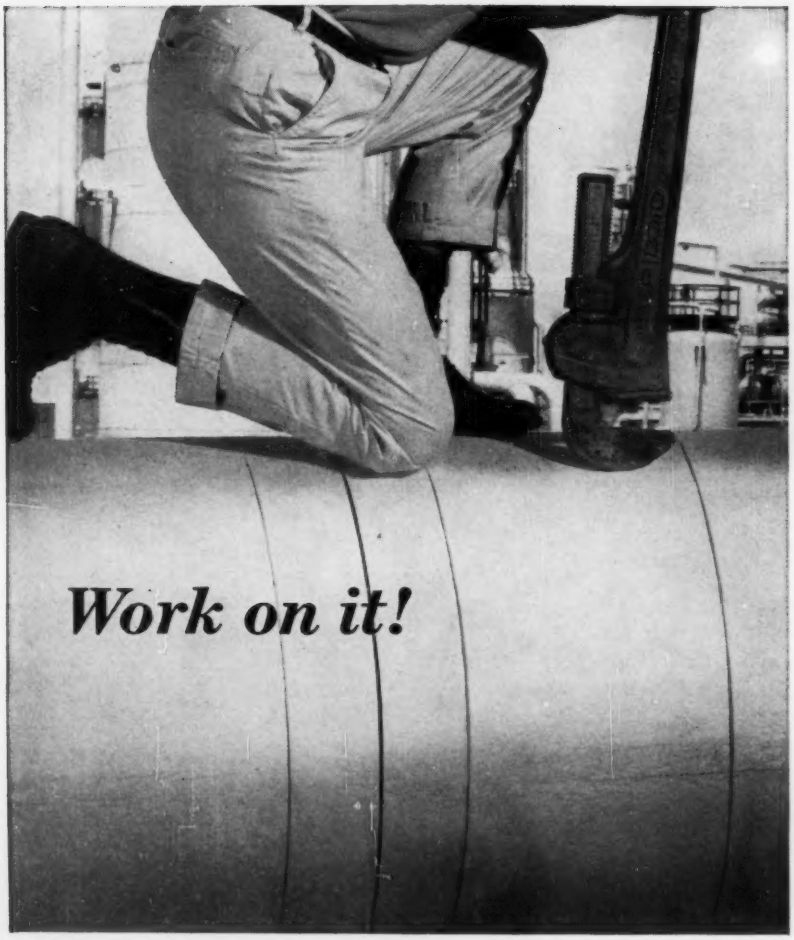
Cooperation with refiners helped Cyanamid develop an answer in Aerocat® micro-spheroidal synthetic catalyst. Aerocat provides high activity, stability, and selectivity through controlled physical properties. You can depend on Aerocat for efficient overall performance and satisfactory product realization.

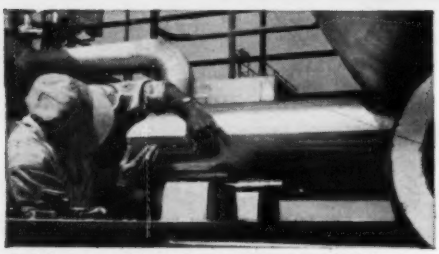
The Cyanamid sales representative—the Man with the Golden Rule—played an important role in developing Aerocat and other catalysts. His job is not simply to sell. His job is to help you in your continuous task to meet the constant challenge. Behind his knowhow are the resources of a major catalyst producer that is also a major manufacturer of other chemicals—Cyanamid. Call when you need the aid of his skill.

Basic in catalyst chemistry

CYANAMID

AMERICAN CYANAMID COMPANY • REFINERY CHEMICALS DEPARTMENT • 30 Rockefeller Plaza, N. Y, 20, N. Y.





J-M's new Metal-On® insulation is Thermobestos prejacketed in aluminum. Snaps on pipe quickly . . . surely. Saves the time and cost of separate on-the-job metal application.

Seminars on best installation practices. For plant foremen who wish to keep up to date on new insulation methods and installation practices, J-M regional sales offices will gladly conduct insulation seminars. Contact nearest J-M office.

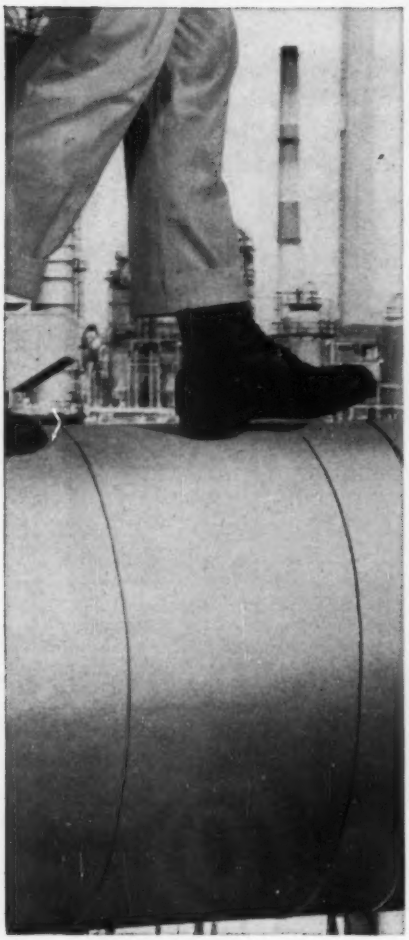
It's tough, durable Johns-Manville

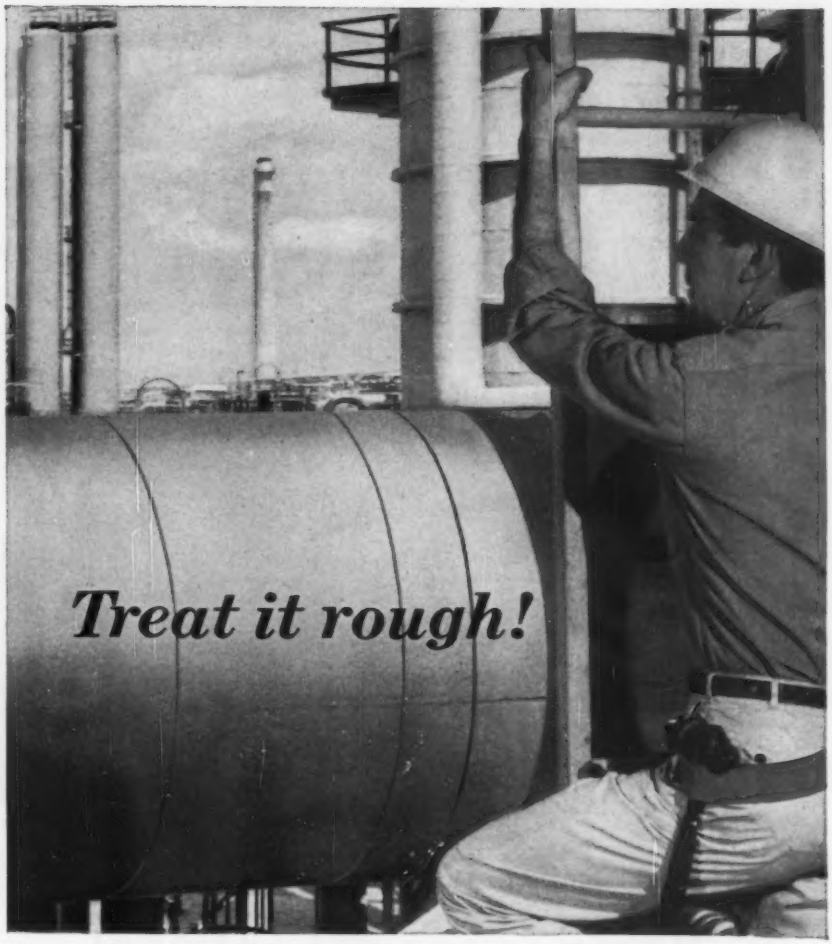
Here's why Thermobestos is the preferred high-temperature calcium-silicate insulation . . . to 1200 F

You know the kind of treatment pipe insulation must take . . . day after day, year after year!

There's no better reason than this for the spiraling growth in Thermobestos® applications throughout the process and power generation industries —an insulation so strong and rigid, so resistant to crushing and compression it is almost structural.

For more data on advertised products, use Readers' Service Cards, last page.





THERMOBESTOS insulation!

Equally important is the ability of Thermobestos to keep fuel costs low. Its *k* factor is the lowest of all insulations generally accepted for process applications. Its moisture resistance, unsurpassed.

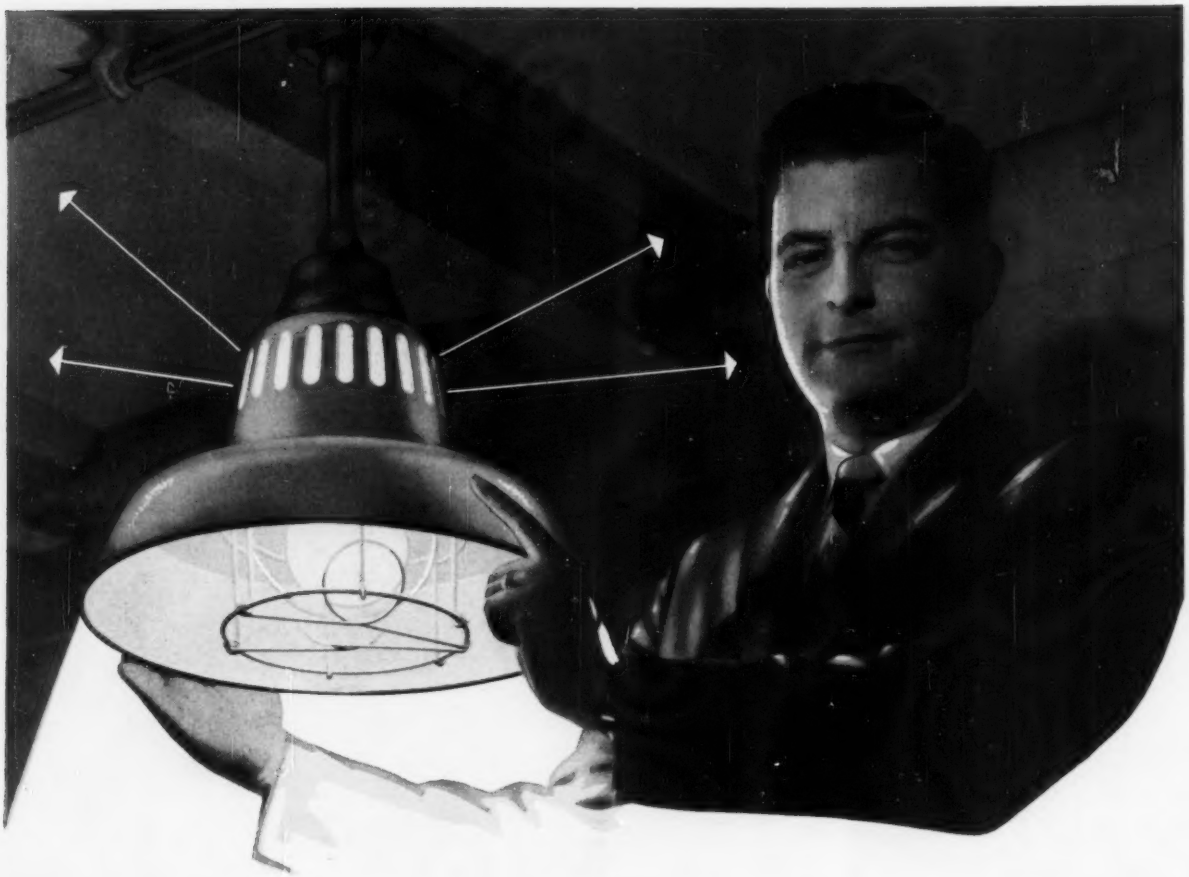
Furnished in large, lightweight sections—precision-molded to unusually close tolerances—Thermobestos is easy to handle and install . . . readily adaptable to shop fabrication of fittings and bonds. Large selection of sizes, thicknesses (and quads up to 33″ pipe size) permit calcium-silicate installations that are entirely Thermobestos insulation.

You'll want the new Thermobestos booklet for your technical file. It contains complete information on prefabricating and installation practices . . . specification data . . . heat transmission tables . . . and physical and thermal characteristics. Write for it today. Ask for booklet IN-169A. Address Johns-Manville, Box 14, New York 16, N.Y. In Canada, 565 Lakeshore Rd. East, Port Credit, Ontario.

JOHNS-MANVILLE PRODUCTS

JOHNS-MANVILLE

For more data on advertised products, use Readers' Service Cards, last page.



Now you can get optional

SLOTTED Reflectors

on these Crouse/Hinds Lighting Fixtures

Explosion-proof—Type EV, Dust-ignition-proof—Type DL in slotted dome or angle reflectors.

Vapor-tight, weather resistant types V and VM in slotted dome or angle reflectors.

Reduce fatigue, accidents and worker tension; improve working environments and employee relations. In both original and replacement installations in major plants, the new slotted reflectors—exclusive with Crouse-Hinds—produce the following results:

- Elimination of dark, dungeon-like areas above reflectors
- Elimination of harsh brightness contrast, improving visibility and seeing comfort
- Reduction of fatigue of workers, and accidents due to fatigue
- Increase of production in machine work, assembly and inspection operations
- Reduce fixture operating temperature and worker discomfort from reflected heat, especially with low-hanging fixtures
- Reduced accumulation of dirt and dust, due to improved air circulation through reflectors
- Slotted reflectors are white enamel finish inside and out

FOR COMPLETE INFORMATION on all Crouse-Hinds lighting fixtures equipped with the new slotted reflectors, call your nearest Crouse-Hinds distributor, or write us.

CROUSE HINDS
SYRACUSE NEW YORK

OFFICES: Atlanta Baton Rouge Birmingham Boston Buffalo Charlotte Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. St. Louis St. Paul Salt Lake City San Francisco Seattle Tulsa Washington
RESIDENT REPRESENTATIVES: Albany Baltimore Reading, Pa. Richmond, Va.
CROUSE-HINDS COMPANY OF CANADA, LTD., TORONTO, ONT. CROUSE-HINDS INSTRUMENT COMPANY, INC., SILVER SPRING, MARYLAND

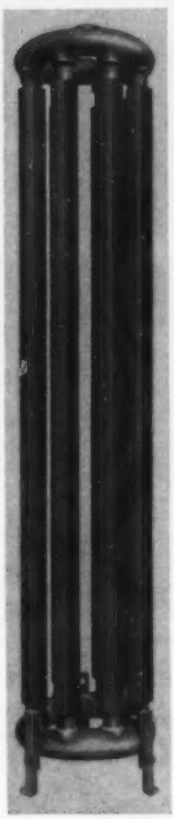
Equipment . . .

face areas. Specifications on circulating steam jets include dimensions and installation instructions.

Nomograms and curves present design information, and sample calculations illustrate the proper application of the equipment under a wide range of operating conditions. National Carbon Co.

Circle E13 green card, last page

Improved Tank Heaters Are Corrosion Resistant



For bulk storage tanks, a new heavy duty finned-tank heater that helps overcome corrosion problems confronting plants that must use poor quality steam, has been developed.

These outstanding new coils have an improved header design which provides (1) exceptional steam distribution characteristics, (2) excellent drainage of condensate and (3) high corrosion allowances. As a result of these features, the manufacturer states that these new heaters, Model TFS-8, last longer, saving thousands of dollars in replacement costs.

- Fintubes reduce skin temperatures (metal wall) thereby reducing coking and/or product discoloration.
- Vertical design sets up thermal siphon action that keeps the tank contents "working"—no stratification or sedimentation.
- Off-the-floor design reduces tank cleaning time for product changes to an absolute minimum. Brown Fintube Co.

Circle E14 green card, last page

Computer Solves Bessel Equation Instantaneously

Before the advent of Dystac computer, simulation of the number of plates required for a given separation in a binary distillation problem could not be economically obtained on a conventional analog computer. The new computer systems development handles this problem as well as multi-component distillation problems.

In a demonstration problem, the number of plates and feed were specified and the unknown was the separation. With Dystac, only 44 amplifiers were employed for solution of a four-component problem; the number of amplifiers required is independent of the number of

'ROUND THE CLOCK . . .

MOBILE GAS STORAGE

WHERE YOU WANT IT

FAST

TW GAS TRANSPORTS

Around the clock around the nation — Taylor-Wharton Gas Transports put mobility in your gas stores moving your gas to where you need it, when you need it.

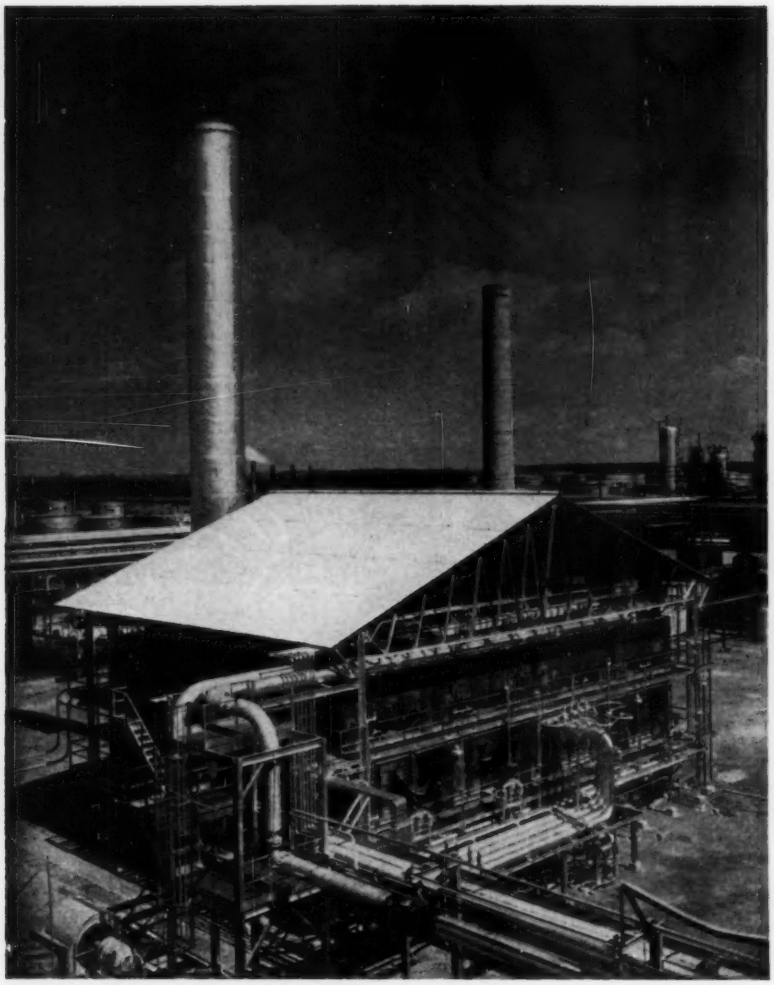
Utilizing a special trailer with either single or tandem axle chassis, upon which are mounted various numbers of pressure vessels (depending upon the gas capacity desired). Large quantities of gas can easily be moved about or put into semi permanent storage.

More than a Century in Harrisburg 2, Pa.

H HARRISBURG STEEL CO.

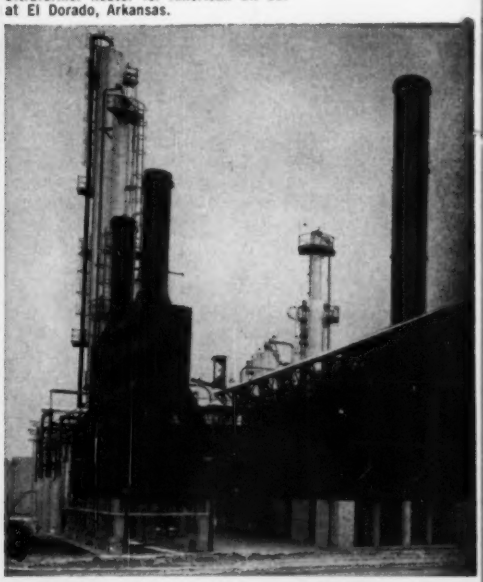
Division of HARSCO CORPORATION

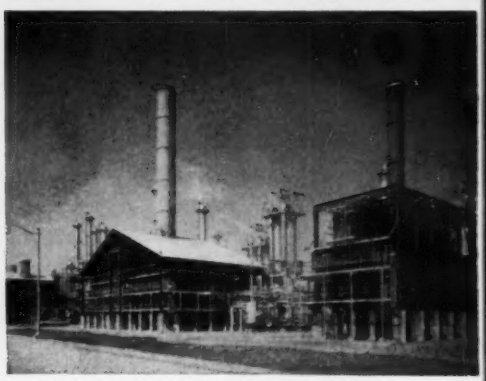
For more data on advertised products, use Readers' Service Cards, last page.



Portable crude heater for Magnolia Petroleum Company, Beaumont, Texas.

Ultraformer heater for American Oil Co. at El Dorado, Arkansas.





Platformer and desulphurizer heaters for Shell Oil Co. at Deer Park, Houston, Texas.

HIGHER EFFICIENCY, LUMMUS OIL HEATERS

Lummus designs horizontal and vertical-tube oil heaters to any size, for any process—anywhere in the world

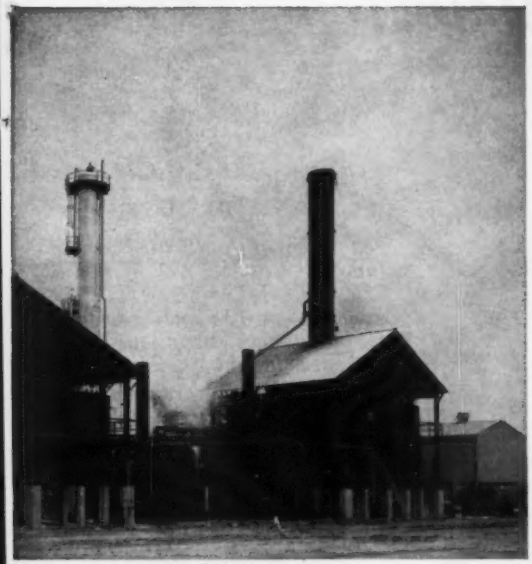
Major refiners confidently turn to Lummus on their important and difficult oil heater jobs.

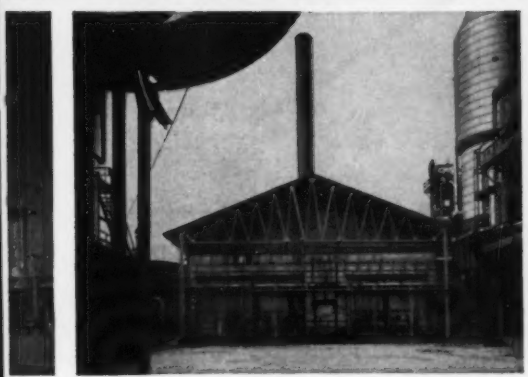
In the last 25 years, the combined capacity of all Lummus oil heaters built has exceeded that of any other company in the world. The reasons: greater durability, more efficient operation, an absolute minimum of days lost to downtime.

Major refiners maintain large engineering and economics staffs who can evaluate the performance of important heating equipment. They buy more Lummus oil heaters because they *know* through statistical comparison that Lummus gives them *more heater per dollar.*

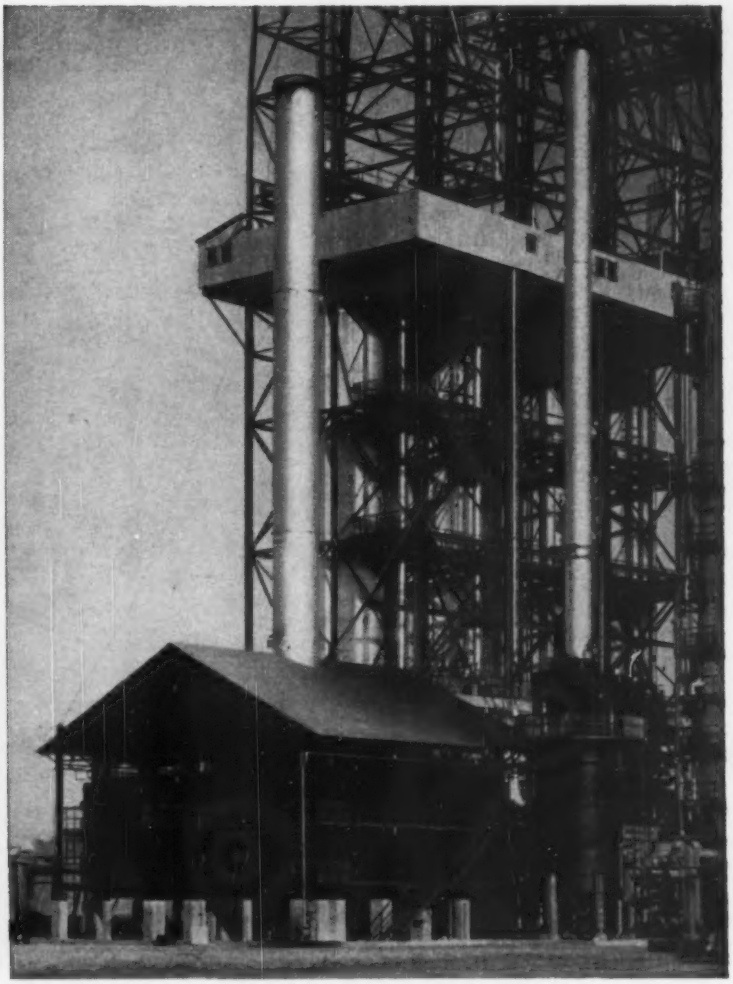
Lummus offers over a quarter of a century of oil heater experience for petroleum refineries, chemical and petrochemical plants. The highly trained engineering staff of the Oil Heater Division is ready in the Lummus New York office to give each job the full benefit of its accumulated know-how in this field.

Lummus oil heaters, of both special and standard design, range from 100,000 to 300,000,000 Btu per hour. As illustrated above, neither size, type nor location of the unit presents a problem to Lummus. Because Lummus offers *every* type of oil heater, you can be sure that we will recommend the *right*





Crude heater for Socony Mobil at Paulsboro, N. J.



Delayed coker heater for the American Oil Co. at Yorktown, Virginia.

MINIMUM DOWNTIME MAKE PREFERRED AMONG MAJOR REFINERS

unit for your needs. Complete Lummus facilities are available world-wide through any of the five international Lummus companies. Equipment is designed in New York, procurement is made through the nearest Lummus international office, and the cost of the job is payable in the currency of the country in which the procurement is handled!

Consult with Lummus on your next oil heater – large or small.

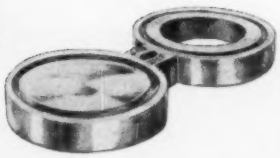
LUMMUS

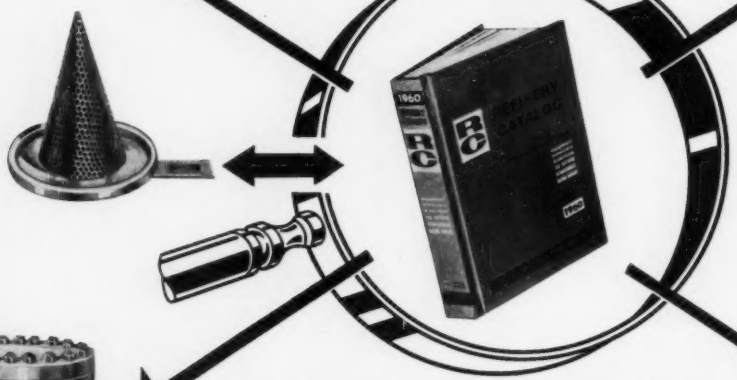
THE LUMMUS COMPANY, OIL HEATER DIVISION
385 MADISON AVENUE, NEW YORK 17, N. Y.

NEWARK • HOUSTON • WASHINGTON, D. C. • MONTREAL • LONDON • PARIS • THE HAGUE • MADRID

MASTER PRODUCTS and CATALOG!

All MAC-IRON stock items, complete with detailed specifications, are listed on pages 653 through 660 of the newly released 1960 Refinery Catalog for your immediate reference.



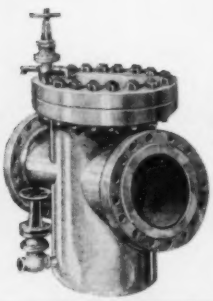


MAC-IRON CATALOG A-9

Although you'll find our full line Catalog A-9 in the 1960 REFINERY CATALOG wouldn't you like more copies for distribution among your important engineering personnel?

Your request will bring all the copies you need. WRITE TODAY . . .

THE MACK IRON WORKS COMPANY
121 Warren Street
SANDUSKY, OHIO
Phone MAin 6-3712



SPECIALISTS TO PETRO-CHEM-REFINING AND CHEM-PROCESS INDUSTRIES SINCE 1901

Stock and custom made items for many engineered applications which involve pumping of fluid materials and operational liquids.

BLINDS • SPACER RINGS • STRAINERS • PIVOT FLANGES

Loosens FROZEN PARTS FAST!

Handy
Won't
Leak
Shoots
3 Feet

Same formula as famous Kroil that has pleased 14,000 industrial users for 10 years or more. Loosens stuck together metal parts, bushings, bearings, bolts, screws, pipe, etc., "anything from an embalmer's needle to a bulldozer," one customer said.

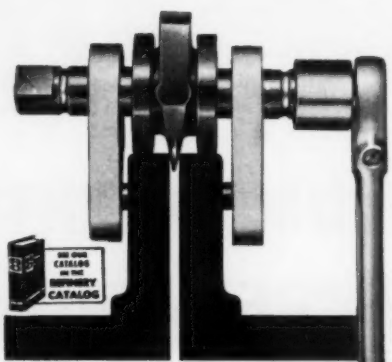
"Like an extra employee," said another. "Turned rust into mush, put $50,000 equipment back to work."

You too can get these results.

Try Aerokroil at our risk. Send $2 cash, and we'll pay postage.

KANO LABS. 1094 Thompson Lane Nashville 11, Tenn.

12-OZ. CAN $2. F.O.B. NASHVILLE CASE OF 12 $18.75



A PIPE DREAM COME TRUE

"SAFETY BOY"
AT LAST! A TOOL TO SPREAD PIPE FLANGES SAFER — FASTER — MORE ECONOMICALLY — IN TIGHTEST WORKING SPACE.

For Catalog Sheet, Write:
Wm. L. Riggs Co.
600 S. 129th E. Ave.
P. O. Box 5002
Tulsa, Oklahoma

With a "Safety Boy" you can spread all types of flanged pipe connections **in seconds,** not hours — to insert blinds, gaskets, orifices. Plant safety hazards and costly down time are eliminated by switching to this really modern pipefitter's tool — "Safety Boy." Wherever there's piping there's a need for "Safety Boy" — the handiest tool ever invented for work in cramped quarters. Lightweight and easy-to-carry, "Safety Boy" is reasonably priced for wide usage.

plates. With conventional computers, each plate must be reproduced in the circuitry; for a 30-plate column over 1,200 amplifiers are required.

With Dystac, the point of introduction of individual components can be regulated, thereby avoiding the need to manipulate small component concentrations (sometimes as low as 10-40) that have no engineering significance. In a digital computer these small numbers must be carried through for continuity.

The demonstration of Bessel equation solving high-lighted other tremendous advantages of the Dystac computer. In this application, the computer performed a trial and error computation driving to the desired equilibrium value at the rate of 60 iterations/second. Solution was reached almost instantaneously. On a conventional analog computer tedious and lengthy manual methods are necessary to arrive at a solution.

The new Dystac system synthesizes the traditional advantages of both analog and digital computers. The analog's speed, lower cost, ease of programming, and improved output data presentation are combined with the digital computer's unique capacity for data storage and time-sharing of computing elements. Computer Systems, Inc.

Circle E15 green card, last page

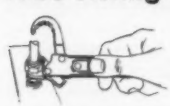
28-Page Booklet Describes 400 Chemicals Properties

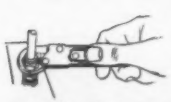
A new 28-page physical properties booklet, describing more than 400 synthetic organic chemicals, has just been published.

The booklet contains information on applications, physical properties, and shipping data. Included are alcohols, acids, anhydrides, chlorine compounds, esters, ethers and oxides, glycol-ethers, glycols and triols, ketones, monomers, polyethylene glycols, metallic salts, nitrogen compounds, cyclic compounds, plasticizers, polypropylene glycols, fluids, lubricants, and fluorocarbons. Also surfactants, water-soluble resins, hydroxyethyl cellulose, new chemicals for evaluation, and chemicals for special applications. Union Carbide Chemicals Co.

Circle E16 green card, last page

Ratchet Wrench Speeds Tube Fitting Assembly





A new light-weight ratchet wrench which speeds fitting assembly and is ideal for work in close quarters is available.

Designated the Kwik-Tite Ratchet Wrench, this new tool is ideal for making up tube fittings, high-pressure hose fittings, hydraulic hose fittings, pipe fittings and other applications. It also may be used for fastening machine nuts and hex fasteners.

To operate, you place the wrench jaws

You specify the features

CEC DESIGNS THE CHROMATOGRAPH

. . . and you save money

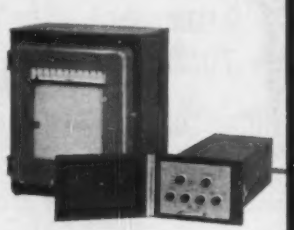
Here's how. Call your nearby CEC representative — ask him about the modular design of CEC's process chromatograph which lets you buy only the features you actually need. Ask him about the new closed-loop control system which can help your plant run itself — and let him show you how you can save money with a stream analyzer tailored by CEC to your exact process operations.

Your design options include: continuous variable attenuation and programming for as many as 12 sample components; precutting to shorten analysis time; multi-stream manifolding for automatic stream switching; polarity reversal; multiple column analysis; and other variations.

For automatic closed-loop control applications, CEC furnishes a final controlled output signal to customer's specifications. *The entire system is described in Bulletin CEC 1859-X1.*

Analytical & Control Division CEC

CONSOLIDATED ELECTRODYNAMICS



CEC process chromatographs consist of a field mounted, explosion-proof analyzer unit and a program control unit designed for remote location at any distance up to 500 feet. **Write for Bulletin CEC 1836-X1.**

over the side of the nut and lift the handle slightly. The wrench will snap closed (as shown in the figure) and ratchet. To remove, simply apply slight hand pressure, moving the wrench handle forward and down. This will cause the jaws to snap open.

Once the wrench is in working position, the harder you pull, the tighter the jaws close . . . but they won't crush even the lightest brass or aluminum fittings, because of the jaw design.

This ratchet makes knuckle scraping jobs a push-over. The wrench needs only a 30 degree handle movement to get a new grip on the nut. This means you can work easily even in the closest quarters. The Imperial Brass Mfg. Co.

Circle E17 green card, last page

Gasoline Additive Removes Carburetor Deposits

A new gasoline additive, Centrol S-41-K, has just been announced.

Engine research, road tests and commercial usage by a major refiner show that the product provides excellent carburetor detergency and anti-icing. It also acts as a mild rust inhibitor. Data of additional significance show that the additive does not contribute to intake valve deposits, ORI, surface ignition, spark plug fouling, sludge or varnish formation, or cause any other detrimental side effects.

At a suggested concentration of 50 ppm the product prevents and gradually removes deposits on the carburetor throat and throttle plate. This use level also provides excellent icing protection for highly volatile gasolines through an unusual synergy with phosphorous additives.

Centrol S-41-K is easy to handle, readily soluble in gasoline and compatible with other kinds of gasoline additives.

The company's 22-page booklet on S-41-K summarizes an extensive series of evaluations which have led to commercial use of the product. Central Soya Co.

Circle E18 green card, last page

Solenoid Valve Catalog Has Been Released

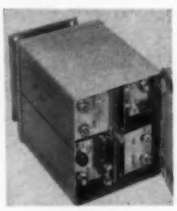
A catalog describing and illustrating a complete line of electrically controlled cagnetic solenoid valves, has been released.

The valve line includes normally closed and normally open solenoid valves used primarily for the control of water, oil. steam, air, solvents, gas and chemicals.

Cross-sectional diagrams as well as photographs are included to completely explain the valve function and operation. Each bulletin is accompanied with specifications in chart form where the individual may select the proper valve required and submit orders complete with price information. Magnatrol Valve Co.

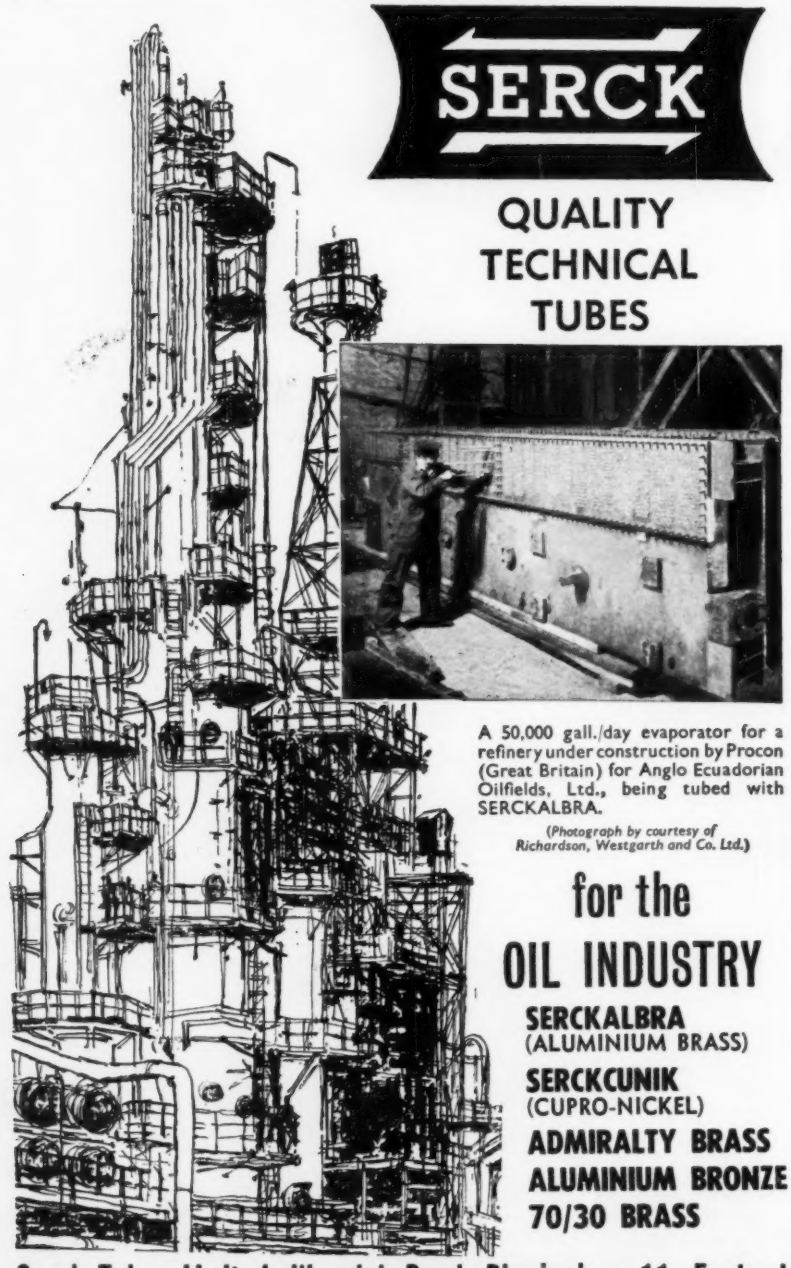
Circle E19 green card, last page

Electronic Alarm Checks On Process Operation



A new, self-powered electronic alarm, the R2A, that can actuate an annunciator or perform an auxiliary control function when a process signal reaches a reset point, has just been introduced. Though equipped with a built-in power supply and adjustable alarm-point signal, the unit can be installed with the alarm-point set from a remote location. This feature offers substantial flexibility in monitoring process variables.

The R2A is a null-balance device that can be used for one- or two-point alarm, operating independently of the instrument circuit or in parallel with any of the company's AutroniC indicator-recorder-controller combinations. The basic components for a single alarm-point are mounted on two printed circuit cards. Each unit has slots for two sets of these cards; permitting both high and low limit



SERCK

QUALITY TECHNICAL TUBES

A 50,000 gall./day evaporator for a refinery under construction by Procon (Great Britain) for Anglo Ecuadorian Oilfields, Ltd., being tubed with SERCKALBRA.

(Photograph by courtesy of Richardson, Westgarth and Co. Ltd.)

for the OIL INDUSTRY

SERCKALBRA (ALUMINIUM BRASS)

SERCKCUNIK (CUPRO-NICKEL)

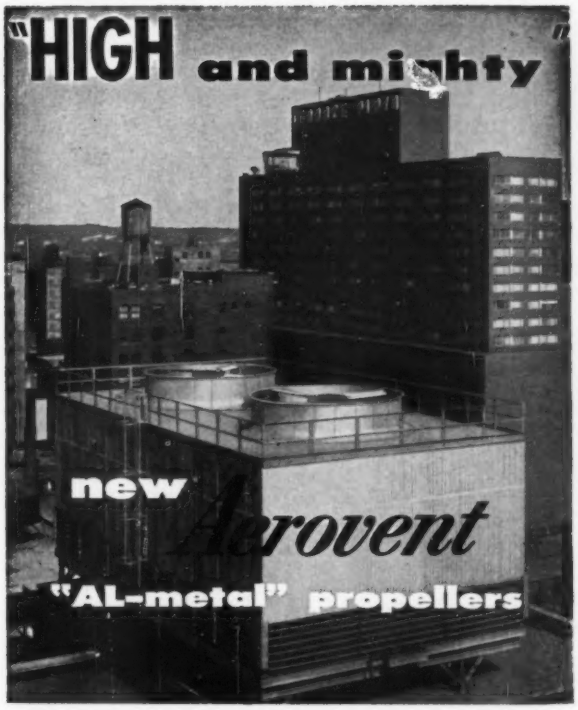
ADMIRALTY BRASS

ALUMINIUM BRONZE

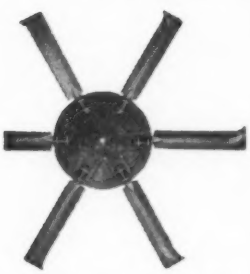
70/30 BRASS

Serck Tubes Limited, Warwick Road, Birmingham 11, England

A member of the Serck Group.



move mountains - of AIR!
in towers and exchangers



- Sizes 14' to 18'
- 4 or 6 blades

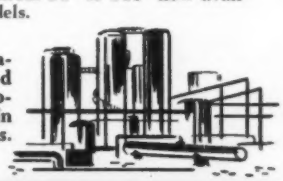
Developed originally for the petroleum industry, Aerovent Large-Diameter "Al-metal" Propellers, constructed of tough, durable aluminum alloy, move great quantities of air at high velocities, in heat exchangers and cooling towers. Pictured above are two 4-blade, 16-ft. propellers in a cooling tower installation. These mighty propellers, with adjustable-pitch "Macheta" Airfoil blades, are job-engineered to individual specifications.

Write for free Bulletin 510

DESIGNED FOR DEPENDABLE OPERATION!

Endurance tests, conducted at *3 times* normal loading prove the ability of these new large-diameter propellers to withstand severe punishment. Heavy-duty cast steel hubs offer maximum resistance to stresses. Angle settings for each operating requirement, and appropriate alternate settings, assure accurate pitch for any predetermined performance which may be required. 54" to 144" now available in Adjustable Pitch Models.

REFINERIES, pumping stations, industrial plants and commercial buildings use Aerovent "Al-metal" Propellers in major air-moving applications.



Aerovent FAN COMPANY, INC.
LARGE PROPELLER DIVISION
304 Wright Bldg. TULSA 3, OKLA.
Main Office and Factory PIQUA, OHIO

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

MAGNETROL

AS DEPENDABLE AS MAGNETIC FORCE ITSELF

● No matter how specialized the liquid level control application, adapting Magnetrol to meet it presents no problem. Whether it's for high pressures, high temperatures, corrosive liquids or any other condition, a few "standard" modifications and the job is done! Operation is so simple no changes in basic design are needed. That's why Magnetrol "fits" practically any application — why "specials" are so often standard with us.

Because of the utter simplicity and dependability of its magnetic principle, Magnetrol has *infinite operating life.* There are no wearing parts to get out of order.

Magnetrols are available for controlling level changes from .0025-in. to 150-ft., with single or multi-stage switching. Our experienced engineering staff is at your service.

MAGNETROL, Inc.

WHY NOT MAIL THE COUPON — NOW

MAGNETROL, Inc., 2112 S. Marshall Blvd., Chicago 23, Illinois
Please send me catalog data and full information on Magnetrol Liquid Level Controls. 7
Name_____
Company_____
Address_____
City_____ Zone_____ State_____

FAST . . . . . Productive

But, that's not all

IT'S RUGGED AND BUILT TO LAST!

LOOK . . .

- Easy To Transport—Only 180 Pounds
- 10 Inches Of Carriage Travel
- Improved Chuck—No Projecting Jaws You Can Work Within 1" Of Face Chip Problem Virtually Eliminated
- Coolant Is Directed Automatically On Work With Easy Flip Of Spout
- Transmission Is Sealed Self-Contained Unit. Easily Accessible. Accurately Cut Helical Gears, Ball Bearing Throughout
- Spindle Bearings Factory Lubricated
- Motor—Ample Power, Easily Accessible
- Full Visibility To Work
- Easy To Read Thread Gauge

Write for literature, or . . .

Call Mr. TOLEDO NOW!

YOUR FRIENDLY DEALER or SUPPLIER

PIPE THREADERS • PIPE WRENCHES • PIPE MACHINES

TOLEDO®

TOLEDO PIPE THREADING MACHINE CO. TOLEDO 4, OHIO

Equipment . . .

alarms. Conversion from one- to two-point alarm, or vice versa, is accomplished by adding or removing a set of printed circuit cards.

When the phase of the grid-driving signal matches the reference signal, the tube stops conducting, and the relay is de-energized until the process signal is corrected. The normally-energized relay provides "fail-safe" action by de-energizing under conditions of tube or line power failure. The Electronic Alarm is suitable for use in Division 2 areas. The Swartwout Co.

Circle E20 green card, last page

Catalog Has Process Industries Equipment

A new catalog guide of equipment for the process industries has just been released.

Included in the guide are descriptions of compressors, vacuum, centrifugal, axial flow and turbine pumps, and valves for fluid flow; crushers and grinding and roller mills for disintegration, mixing and agglomeration; vibrating and gyratory screens for dry separation; blade mills, pool washing screens and log washers for liquid separation; kilns, dryers, slakers, pelletizers, coolers, and liquid heaters for heat transfer.

The guide also covers electrical equipment for the complete process plant, electronic metal detectors, water conditioning equipment, chemicals and service, as well as car shakers, lift trucks, tractors, etc. Allis-Chalmers Mfg. Co.

Circle E21 green card, last page

New High Strength Nickel Alloy Steel Family Found

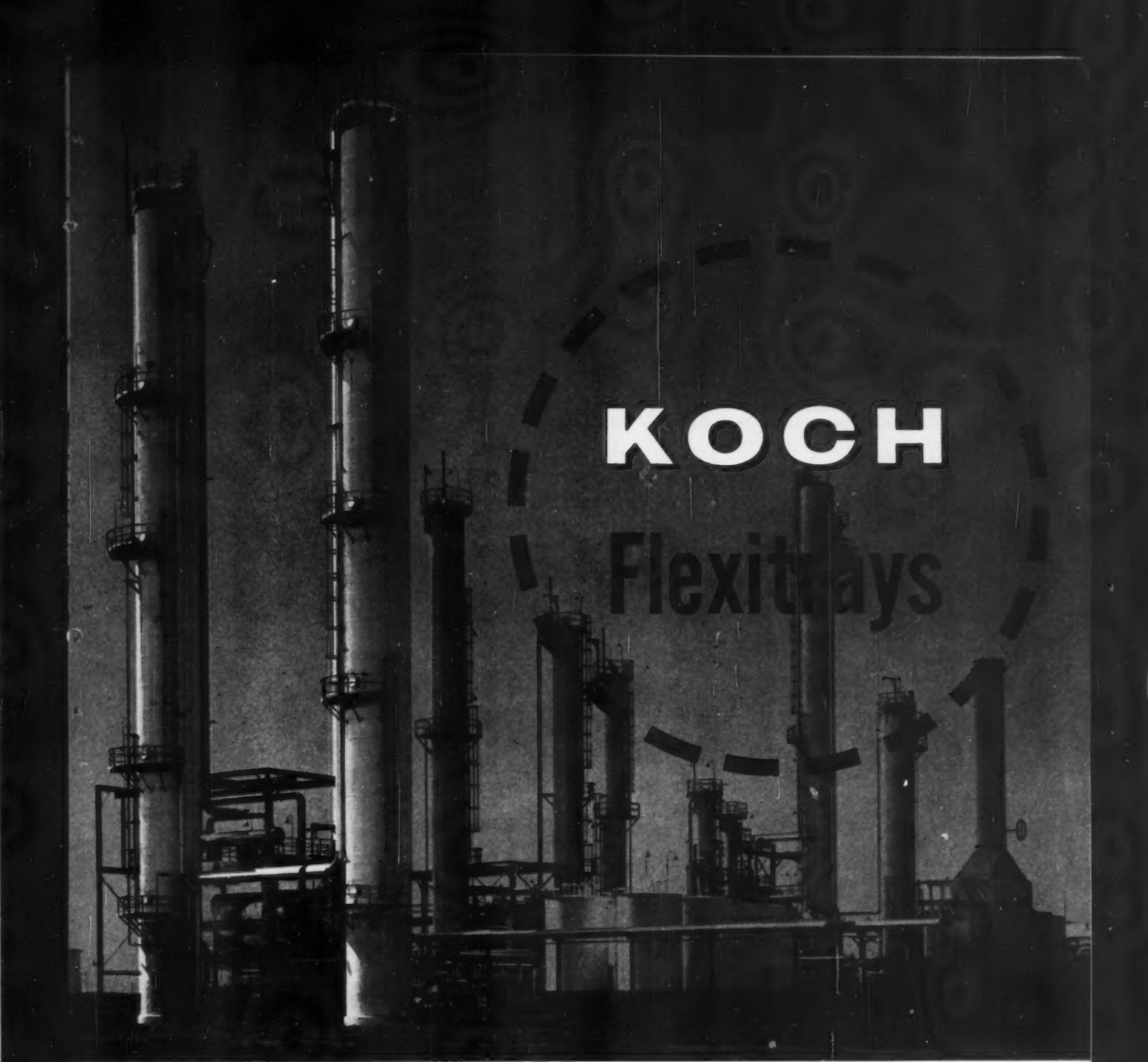
A remarkable new family of very high-strength nickel alloy steels has been invented.

Nominally identified as 25 percent nickel steels, these new alloys achieve unique properties by simply air cooling from the heat treating temperatures. Yield strengths in excess of 250,000 psi with 6 to 10 percent elongation and above 20 percent reduction of area are obtainable in section thicknesses where such high-strength properties were not heretofore attained. In some cases yield strengths in excess of 290,000 psi have been achieved. Maximum hardness in excess of 67 Rockwell C has been obtained.

Many of these new steels also possess excellent cold forming characteristics after a simple annealing treatment which consists merely of air cooling from solution temperature. In this condition, they have a yield strength of the order of mild steel.

Another unusual feature of the 25 percent nickel steels is that they are weldable in the hardened condition without pre-heat. This feature together with the extremely high strength properties, which are not limited to thin sections, is expected to lead to important applications such as in heavy-wall pressure vessels

For more data on advertised products, use Readers' Service Cards, last page.



help maintain high purity in Xylene Splitter at Suntide

This Xylene Splitter at Suntide Refining Company in Corpus Christi, Texas, produces, on a charge of 1500 B/D, of mixed xylenes, an overhead product normally containing 1.0% orthoxylene and a bottom product containing 94% orthoxylene.

Consisting of two towers side-by-side, connected in series due to height limitation, Suntide's Xylene Splitter has operated with as high a feed rate as 1800 B/D. Each tower, 130 feet high by 10 feet — 6 inches in diameter, contains 60 Koch Flexitrays. . . for a total of 120 trays.

Koch Flexitrays are the most dependable and economical devices yet developed for distillation, absorption, and stripping. On **your** next tower be sure to investigate **Flexitrays.** The extreme flexibility of this low-priced tray has resulted in its use in more than 1,000 non-captive installations.

"Continuing progress through research"

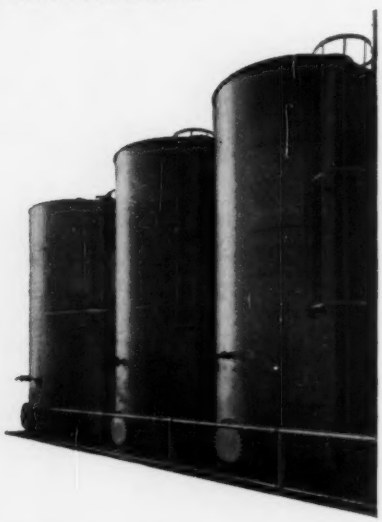
See why ALCOA ALUMINUM makes a good design habit

Requirement: A better way to store process liquids and gases
Key to Good Design: Use Alcoa Aluminum Storage Tanks

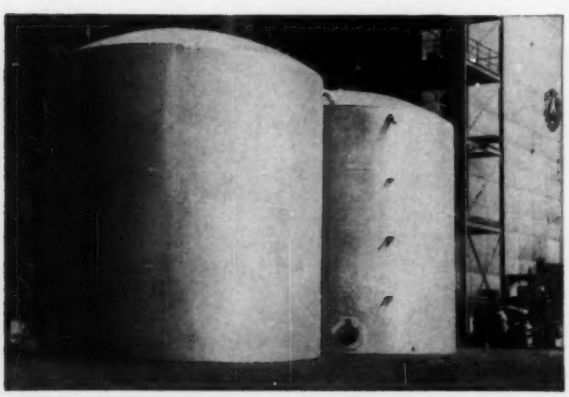
Whether product storage is an intermediate or final step in your processing operation, ALCOA® Aluminum Storage Tanks can help cut costs and maintain product purity. The production of glacial acetic acid is a prime example. For over 30 years ALCOA Aluminum tanks have been specified for storing this chemical because they resist corrosion and offer real economies in initial investment and in freedom from maintenance costs.

Thousands of aluminum tanks and tank cars have been constructed for the transport and storage of such chemicals as ammonium nitrate solutions, acrylonitrile, cryogenic substances and sour crude oils. Some of the many other products for which aluminum alloy tanks are well suited are listed below.

ALCOA can supply aluminum storage tanks for practically any processing application. They are made in a number of sizes ranging from 580 to 21,480 gal and are available in both horizontal and vertical construction.



Oleic acid is one of the many chemicals often stored in aluminum tanks. Aluminum preserves the color and purity of this product.



Fabricated from 3003 aluminum alloy, ALCOA Standard Storage Tanks measure 10 ft in diameter with varying lengths for different capacities. ALCOA also supplies special storage tanks to many processors. These can be furnished in intermediate lengths and capacities, and in a wide range of aluminum alloys for many process applications.

ALCOA engineers have worked closely with all segments of the process industries for over 40 years, and can help you specify the aluminum alloy storage tanks and other equipment best suited for your particular process application. ALCOA's unparalleled experience in this field is available to you for the asking. Write to the address on the coupon, stating your requirements as specifically as possible. ALCOA's development engineers will welcome the opportunity to work with you on your problems.

You can also take advantage of the wide selection of free ALCOA literature on aluminum for storage tanks and other process applications. Simply check the booklets you want on the coupon and mail to the address indicated. ALCOA will forward your material promptly and without obligation.

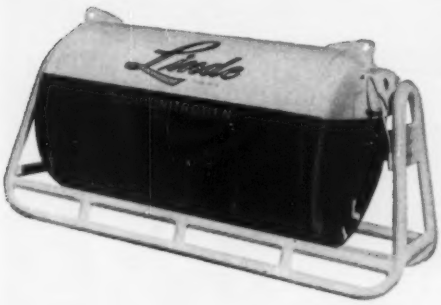
During 1959, ALCOA will conduct engineering conferences in a number of major cities on process industries applications of aluminum. Contact your nearest ALCOA sales office for full particulars and dates.

Typical chemicals stored in ALCOA tanks

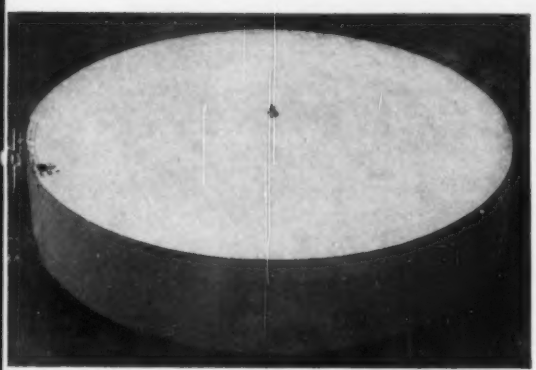
Acetaldehyde
Acetic acid, glacial
Acetic anhydride
Acetone
Acrylic acid, glacial
Acrylonitrile
Adipic acid
Ammonium carbonate
Ammonium nitrate solutions
Ammonium thioglycolate
Amyl mercaptan
Animal oils
Benzene
Butyl alcohols
Cellulose acetate
Edible oils
Ethyl acetate
Ethyl alcohol
Ethylene glycol
Fatty acids
Gasoline
Glycerine (natural & synthetic)
Glycerol phosphate
Lacquer
Methyl alcohol
Napthenic acids
Naval stores
Nitric acid (above 82% conc.)
Nylon salts
Oleic acid
Phenol
Propyl alcohols
Propylene glycol
Resins
Rosin
Sorbitol
Solvents
Stearic acid
Sugar solutions
Toluene
Trichlorobenzene
Turpentine
Water (distilled or deionized)
Waxes

These aluminum storage tanks maintain the purity of steam condensate for a large public utility.

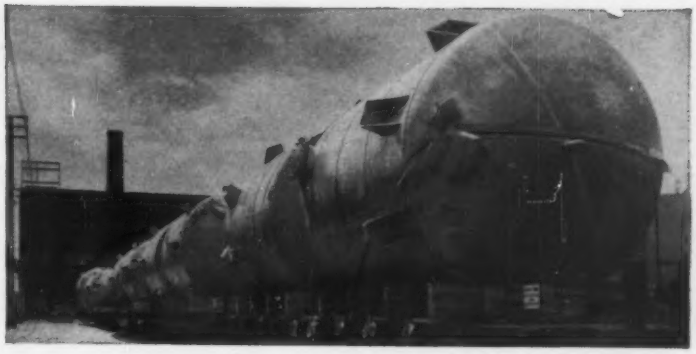
Fatty acids are not discolored by contact with aluminum.



Aluminum's light weight assures easy handling and storage for this 600-liter nitrogen container. The tank is fabricated from Alcoa Aluminum Alloy 5154.



The world's largest all-aluminum tank stores 2⅓ million gal of ammonium nitrate at 180°F. Prime consideration here was the need for uninterrupted storage service with a minimum of maintenance. The tank stands 26 ft high, and has a diameter of 128 ft.



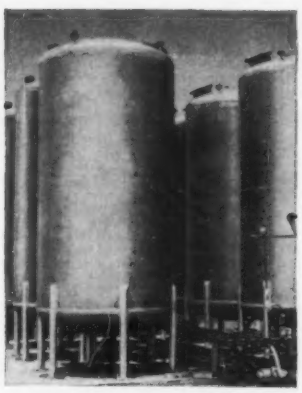
Typical mechanical properties of Alcoa Aluminum Alloys

Alloy and Temper	Tension			Hardness, (2)	Shear Ultimate ksi	Fatigue Endurance Limit, ksi	Modulus of Elasticity ksi
	Strength, Ultimate	ksi Yield	Elongation % in 2 in. (1)				
5052-O	28	13	25	47	18	16	10,200
5083-O	42	21	22	73	26		10,300
5086-O	38	17	22	65	23		10,300
5154-O	35	17	27	60	22	17	10,200
5454-O	36	17	22	62	23		10,200
5456-O	45	23	24	75	28		10,300

(1) ⅛-in. thick specimen
(2) Brinell; 500-kg load, 10-mm ball

ASME design stress values for various Alcoa Aluminum Alloys (psi at 100 degrees F)

5052..... 6,250 psi
5083.....10,000 psi
5086..... 8,700 psi
5154..... 7,350 psi
5456.....10,500 psi



Alcoa standard tanks are constructed of stock components and are available for fast delivery. They provide the safest storage for a wide variety of chemicals, petrochemicals and petroleum products.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

For exciting drama watch "ALCOA THEATRE," alternate Mondays, NBC-TV, and "ALCOA PRESENTS," every Tuesday, ABC-TV

Aluminum Company of America
879-A Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature covering Alcoa Aluminum for storage tanks and other uses in the process industries:

- ☐ 10387 Alcoa Standard Storage Tanks
- ☐ 10460 Process Industries Applications of Alcoa Aluminum
- ☐ 10508 Cleaning and Maintenance
- ☐ 20849 Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres
- ☐ 20265 Have You Tried Aluminum in Your Refinery?
- ☐ GL93 Aluminum in the Pulp and Paper Industry
- ☐ 20268 Resistance of Aluminum Alloys to Fresh Waters

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Company_____ Title_____

Address_____

City_____ State_____

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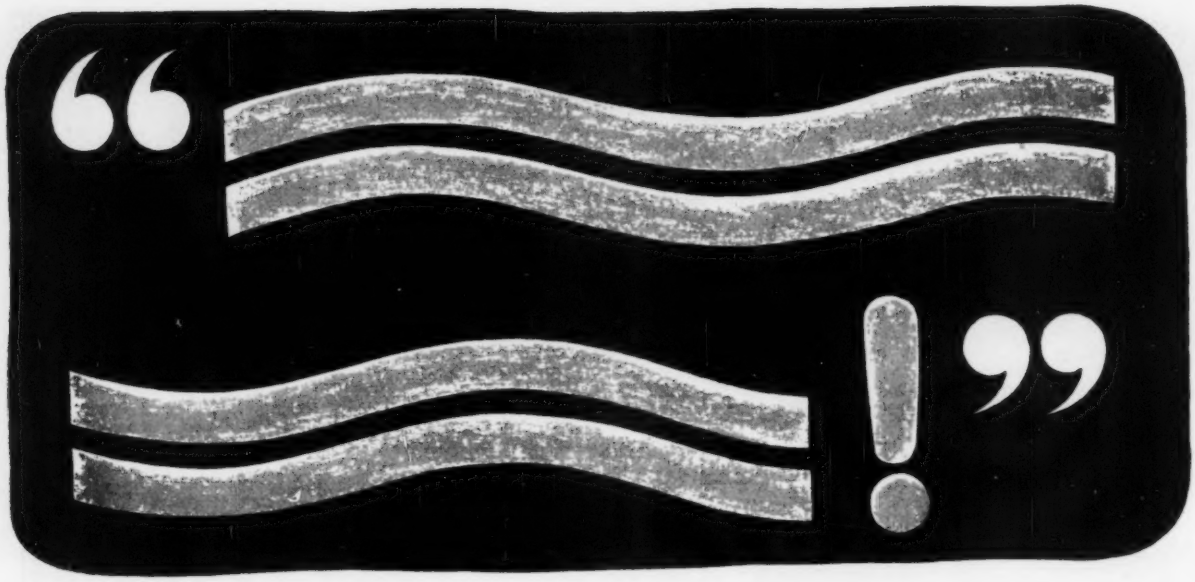


Fluid, fluent communications...

the answer to greater understanding and effectiveness in engineering

Productive communications — the quick, accurate and understandable transmittal of ideas, conclusions and decisions — from drawing board to fabrication — play a vital role in the design and manufacture of Western Heat Exchangers . . . and are greatly responsible for the reputation Western enjoys for personal attention to the detail of each customer's needs.
Western's design, rating and service efficiency, as well as its quality of workmanship, depend upon maintaining "fluid, fluent" communications with our customers and our own personnel. We would be pleased to establish this "line of communication" with your engineering department, when you next require heat transfer equipment.

WESTERN'S STAKE IN YOUR FUTURE

. . . is in your young engineers — the engineering executives of tomorrow. In 1960, therefore, Western presents a series of messages on subjects of importance to the personal and professional advancement of all engineers. These messages, as shown at right, appear monthly in major trade journals, with a more complete treatment of each subject available in pamphlet form, singly or in quantities, upon request.

One of a series appearing in OIL & GAS JOURNAL, CHEMICAL ENGINEERING, PETROLEUM REFINER, REFINING ENGINEER, CHEMICAL ENGINEERING PROGRESS.

serving the growth of the process industry

WESTERN

HEAT EXCHANGERS

WESTERN SUPPLY COMPANY

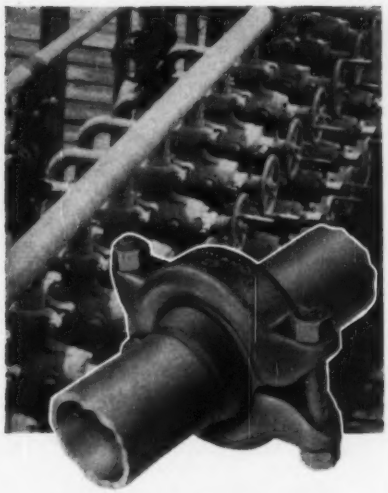
P.O. Box 1888 – Tulsa, Oklahoma

Communicating your convictions gains better understanding, improved relations, greater results for engineers

Breathes there a man with soul so dead, who never to his friend has said, "Don't those lamebrains in the Department every get ANYTHING right? . . . I very carefully wrote EVERYTHING down, very logically and clearly . . . didn't leave a thing out . . . and they still don't get my point!" — or words to that effect?

The only qualification you need for having voiced these sentiments is that you occupy yourself daily with one or

For more data on advertised products, use Readers' Service Cards, last page.



GRAYLOC

Pipe Connections Make-Up In 3 Minutes

Unlike the 3-minute egg or the 3-minute car wash, GRAYLOC 4-inch Pipe Connections actually can be made up in 3 minutes by an unskilled laborer. What's more, the connection will test up to 10,000 p.s.i. every time. Two men can make-up a 24-inch connection in 15 minutes.

GRAYLOC, with its new principle in pipe make-up, can be broken out and re-made repeatedly with no wear or other damage to the connections and without replacement of the seal ring.

The GRAYLOC principle features flexible tapered lips of the seal which are angled slightly less than the mating hub. This forms a line seal which is changed to a surface seal as the connection comes together and the lips deflect. This design makes it possible for GRAYLOC to withstand full vacuum, high external pressure or extreme internal pressure.

GRAYLOC has practical applications in missile, chemical, petroleum, and atomic energy processes.

For additional information, write, wire or telephone Gray Tool Company.

GRAY *Tool Company*

P. O. BOX 2291 HOUSTON, TEXAS
REpublic 4-1641 5905

Equipment . . .

and in heavy defense equipment.

Although the combination of mechanical properties is affected by varying the nickel content from as high as 30 percent down to 20 percent or lower, with suitable additions of titanium and aluminum, the optimum combination of strength and ductility appears to be at about 25 percent nickel, with 2 to 6 percent titanium and/or aluminum, carbon held as low as possible and preferably below 0.05 percent, silicon and manganese normal, and the balance iron. The International Nickel Co., Inc.

Circle E22 green card, last page

New Plastic Lined Pipe And Fittings Used To 280° F

Development of the first all-Penton and Penton-lined metal fittings and the first metal pipe with injection-molded Penton lining for handling solvents and hot corrosive fluids in process piping, has been announced.

"Penton" is the new chlorinated polyether thermoplastic credited with exceptional corrosion resistance and ability to handle elevated temperatures, including low-pressure steam.

Initial production plans call for all-Penton elbows, tees, couplings, caps, plugs, flanges, unions, nipples, reducer couplings and reducer bushings to be produced in ½ to 2 inch sizes, threaded and socket type, Schedule 80, to match presently available 20-foot lengths of Penton pipe. Carbon steel and aluminum pipe lined with injection-molded Penton and Penton-lined cast iron and cast-aluminum flanged fittings, including elbows, tees and steel-flanged Penton-lined stub ends, are planned in ½ through 3 inch sizes. Lined fittings will conform to ASA B16.1, Class 125 dimensions.

All-Penton pipe and fittings can be joined readily by thermal welding of socket-type fittings or by threaded connections, with a back weld recommended. The lined fittings are flanged for bolting and have raised faces. Lengths of lined pipe ran be joined by threaded or welded flanged connections or by a thermal butt weld reinforced with a light-wall steel connecting sleeve. Tube Turns Plastics, Inc.

Circle E23 green card, last page

REFRACTORY HAYDITE

Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.

We sell direct to you.

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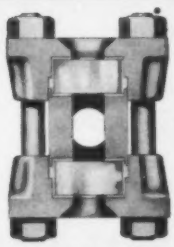
HIGH PRESSURE GAUGES

USED IN REFINERIES *AND* CHEMICAL PLANTS *THROUGHOUT THE WORLD*



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Single or Multiple Sections

TUBULAR

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•
Large Chamber Reflex Gauges
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Heated or Cooled Gauges

SEND FOR COMPLETE CATALOGUE

STRAHMAN VALVES, Inc.
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*The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1960 Refinery Catalog.

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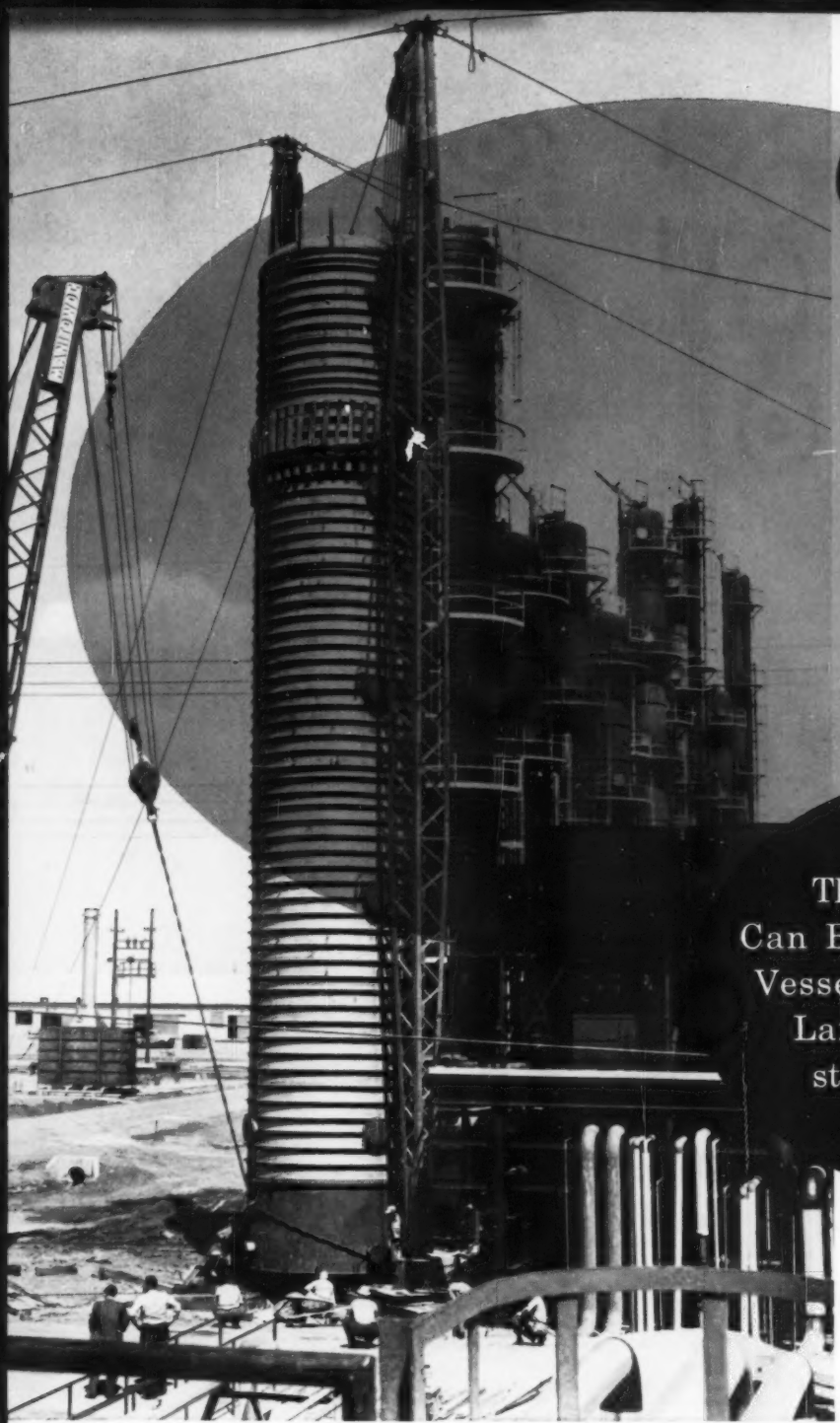

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